R&S®FSV-K100/-K102/-K104 EUTRA / LTE Downlink Measurement Application

User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following software applications:

- R&S FSV-K100 EUTRA / LTE FDD Downlink Measurement Application (1310.9051.02)
- R&S FSV-K100 EUTRA / LTE MIMO Downlink Measurement Application (1309.9000.02)
- R&S FSV-K104 EUTRA / LTE TDD Downlink Measurement Application (1309.9774.02)

The contents of this manual correspond to the following R&S®FSVR models with firmware version 1.56 or higher:

- R&S®FSVR7 (1311.0006K7)
- R&S®FSVR13 (1311.0006K13)
- R&S®FSVR30 (1311.0006K30)
- R&S®FSVR40 (1311.0006K40)

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The following abbreviations are used throughout this manual: R&S®FSV-K100 is abbreviated as R&S FSV-K100, R&S®FSV-K102 is abbreviated as R&S FSV-K102, R&S®FSV-K104 is abbreviated as R&S FSV-K104 and R&S®FSV is abbreviated as R&S FSV.

Contents

1 Preface

1.1 Documentation Overview

The user documentation for the R&S FSVR is divided as follows:

- Quick Start Guide
- Operating Manuals for base unit and options
- Service Manual
- Online Help
- Release Notes

Quick Start Guide

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and basic measurements are described. Also a brief introduction to remote control is given. The manual includes general information (e.g. Safety Instructions) and the following chapters:

Chapter 1	Introduction, General information
Chapter 2	Front and Rear Panel
Chapter 3	Preparing for Use
Chapter 4	Firmware Update and Installation of Firmware Options
Chapter 5	Basic Operations
Chapter 6	Basic Measurement Examples
Chapter 7	Brief Introduction to Remote Control
Appendix 1	Printer Interface
Appendix 2	LAN Interface

Operating Manuals

The Operating Manuals are a supplement to the Quick Start Guide. Operating Manuals are provided for the base unit and each additional (software) option.

The Operating Manual for the base unit provides basic information on operating the R&S FSVR in general, and the "Spectrum" mode in particular. Furthermore, the software options that enhance the basic functionality for various measurement modes are described here. The set of measurement examples in the Quick Start Guide is expanded by more advanced measurement examples. In addition to the brief introduction to remote control in the Quick Start Guide, a description of the basic analyzer commands and programming examples is given. Information on maintenance, instrument interfaces and error messages is also provided.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSVR is not included in the option manuals.

The following Operating Manuals are available for the R&S FSVR:

- R&S FSVR base unit; in addition:
  – R&S FSV-K9 Power Sensor Support
  – R&S FSV-K14 Spectrogram Measurement
- R&S FSV-K7 Analog Demodulation and R&S FSV-K7S FM Stereo Measurements
- R&S FSV-K10 GSM/EDGE Measurement
- R&S FSV-K30 Noise Figure Measurement
- R&S FSV-K40 Phase Noise Measurement
- R&S FSV-K70 Vector Signal Analysis Operating Manual
  R&S FSV-K70 Vector Signal Analysis Getting Started (First measurements)
- R&S FSV-K72 3GPP FDD BTS Analysis
- R&S FSV-K73 3GPP FDD UE Analysis
- R&S FSV-K76/77 3GPP TD-SCDMA BTS/UE Measurement
- R&S FSV-K82/83 CDMA2000 BTS/MS Analysis
- R&S FSV-K84/85 1xEV-DO BTS/MS Analysis
- R&S FSV-K91 WLAN IEEE 802.11a/b/g/j/n
- R&S FSV-K93 WiMAX IEEE 802.16 OFDM/OFDMA Analysis
- R&S FSV-K100/K104 EUTRA / LTE Downlink Measurement Application
- R&S FSV-K101/K105 EUTRA / LTE Uplink Measurement Application

These manuals are available in PDF format on the CD delivered with the instrument. The printed manual can be ordered from Rohde & Schwarz GmbH & Co. KG.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSVR by replacing modules. The manual includes the following chapters:

Chapter 1	Performance Test
Chapter 2	Adjustment
Chapter 3	Repair
Chapter 4	Software Update / Installing Options
Chapter 5	Documents

Online Help

The online help contains context-specific help on operating the R&S FSVR and all available options. It describes both manual and remote operation. The online help is installed on the R&S FSVR by default, and is also available as an executable .chm file on the CD delivered with the instrument.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The current release notes are provided in the Internet.

1.2 Conventions Used in the Documentation

1.2.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.2.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touch screen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

1.3 How to Use the Help System

Calling context-sensitive and general help

► To display the general help dialog box, press the HELP key on the front panel.

The help dialog box "View" tab is displayed. A topic containing information about the current menu or the currently opened dialog box and its function is displayed.

For standard Windows dialog boxes (e.g. File Properties, Print dialog etc.), no context-sensitive help is available.

► If the help is already displayed, press the softkey for which you want to display help.

A topic containing information about the softkey and its function is displayed.

If a softkey opens a submenu and you press the softkey a second time, the submenu of the softkey is displayed.

Contents of the help dialog box

The help dialog box contains four tabs:

- "Contents" - contains a table of help contents
- "View" - contains a specific help topic
- "Index" - contains index entries to search for help topics
- "Zoom" - contains zoom functions for the help display

To change between these tabs, press the tab on the touchscreen.

Navigating in the table of contents

- To move through the displayed contents entries, use the UP ARROW and DOWN ARROW keys. Entries that contain further entries are marked with a plus sign.
- To display a help topic, press the ENTER key. The "View" tab with the corresponding help topic is displayed.
- To change to the next tab, press the tab on the touchscreen.

Navigating in the help topics

- To scroll through a page, use the rotary knob or the UP ARROW and DOWN ARROW keys.
- To jump to the linked topic, press the link text on the touchscreen.

Searching for a topic

1. Change to the "Index" tab.

2. Enter the first characters of the topic you are interested in. The entries starting with these characters are displayed.
3. Change the focus by pressing the ENTER key.
4. Select the suitable keyword by using the UP ARROW or DOWN ARROW keys or the rotary knob.
5. Press the ENTER key to display the help topic.

   The "View" tab with the corresponding help topic is displayed.

Changing the zoom

1. Change to the "Zoom" tab.
2. Set the zoom using the rotary knob. Four settings are available: 1-4. The smallest size is selected by number 1, the largest size is selected by number 4.

Closing the help window

► Press the ESC key or a function key on the front panel.

2 Introduction

Overview of the LTE measurement application

This manual contains all information that you need to work with the LTE measurement application like manual operation or remote control operation.

The manual covers all LTE Uplink firmware applications that are available for the R&S FSVR:

- R&S FSV-K100 (LTE Downlink FDD)
- R&S FSV-K104 (LTE Downlink TDD)

The LTE measurement applications make use of the I/Q capture functionality of the R&S FSVR. The I/Q capture enables EUTRA/LTE TX measurements in accordance with the EUTRA specification.

This part of the documentation covers only functions that are particular to the firmware application. For all other functionality, refer to the description of the base unit.

3 Introduction

The R&S FSVR-K100/-K104 EUTRA/LTE Downlink Measurement Application uses the I/Q capture functionality of the R&S FSVR spectrum analyzer to enable EUTRA/LTE TX measurements in line with the EUTRA specification.

This manual supports the user in working with this software. It describes how to prepare, execute, and evaluate a measurement and gives many helpful hints and examples.

3.1 EUTRA / LTE

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

3.1.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.
- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.
- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.
- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.
- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.
- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.
- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.
- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.
- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.
- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.
- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.
- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.
- Network synchronization: Time synchronization of different network sites shall not be mandated.

3.1.2 Long-Term Evolution Downlink Transmission Scheme

3.1.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM. In an OFDM system, the available spectrum is divided into multiple carriers, called subcarriers, which are orthogonal to each other. Each of these subcarriers is independently modulated by a low rate data stream.

OFDM is used as well in WLAN, WiMAX and broadcast technologies like DVB. OFDM has several benefits including its robustness against multipath fading and its efficient receiver architecture.

figure 3-1 shows a representation of an OFDM signal taken from 3GPP TR 25.892 [2]. In this figure, a signal with 5 MHz bandwidth is shown, but the principle is of course the same for the other EUTRA bandwidths. Data symbols are independently modulated and transmitted over a high number of closely spaced orthogonal subcarriers. In EUTRA, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

In the time domain, a guard interval may be added to each symbol to combat inter-OFDM-symbol-interference due to channel delay spread. In EUTRA, the guard interval is a cyclic prefix which is inserted prior to each OFDM symbol.

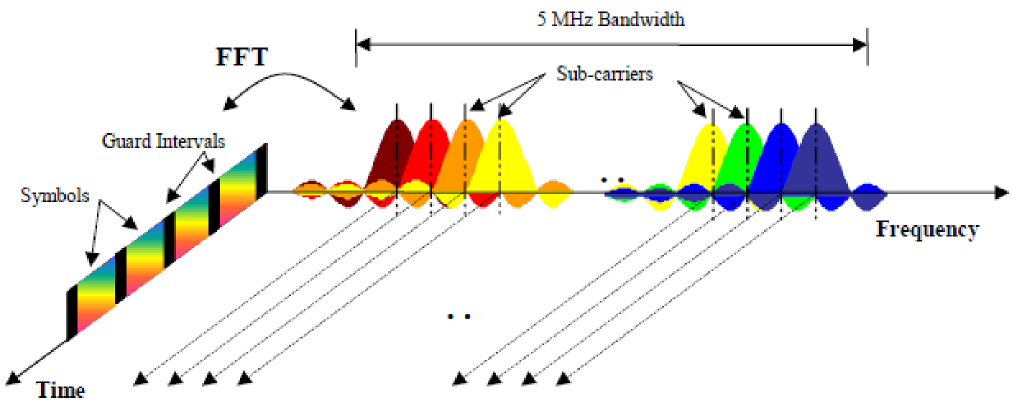


Fig. 3-1: Frequency-Time Representation of an OFDM Signal

In practice, the OFDM signal can be generated using the inverse fast Fourier transform (IFFT) digital signal processing. The IFFT converts a number N of complex data symbols used as frequency domain bins into the time domain signal. Such an N-point IFFT is illustrated in figure 3-2, where a(mN+n) refers to the n^{th} subchannel modulated data symbol, during the time period $mT_u < t \leq (m+1)T_u$.

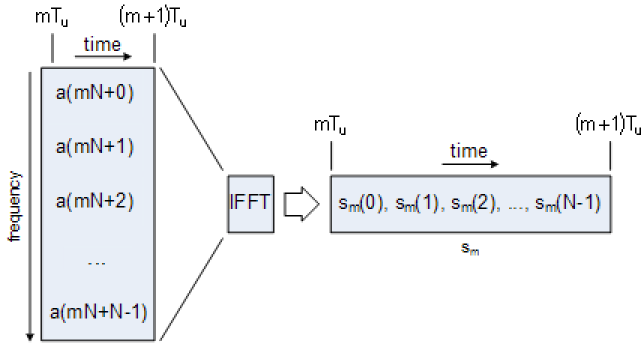


Fig. 3-2: OFDM useful symbol generation using an IFFT

The vector s_m is defined as the useful OFDM symbol. It is the time superposition of the N narrowband modulated subcarriers. Therefore, from a parallel stream of N sources of data, each one independently modulated, a waveform composed of N orthogonal subcarriers is obtained, with each subcarrier having the shape of a frequency sinc function (see figure 3-1).

figure 3-3 illustrates the mapping from a serial stream of QAM symbols to N parallel streams, used as frequency domain bins for the IFFT. The N-point time domain blocks obtained from the IFFT are then serialized to create a time domain signal. Not shown in figure 3-3 is the process of cyclic prefix insertion.

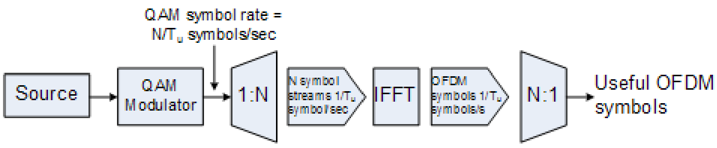


Fig. 3-3: OFDM Signal Generation Chain

In contrast to an OFDM transmission scheme, OFDMA allows the access of multiple users on the available bandwidth. Each user is assigned a specific time-frequency resource. As a fundamental principle of EUTRA, the data channels are shared channels, i.e. for each transmission time interval of 1 ms, a new scheduling decision is taken regarding which users are assigned to which time/frequency resources during this transmission time interval.

3.1.2.2 OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in figure 3-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).

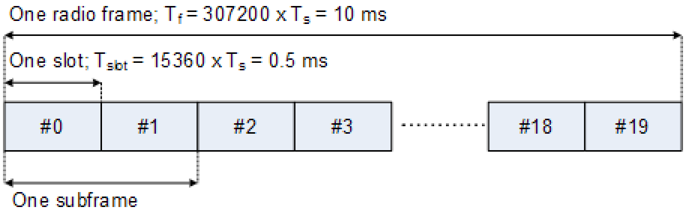


Fig. 3-4: Generic Frame Structure in EUTRA Downlink

figure 3-5 shows the structure of the downlink resource grid for the duration of one downlink slot. The available downlink bandwidth consists of N_{BW}^{DL} subcarriers with a spacing of Δf = 15 kHz. In the case of multi-cell MBMS transmission, a subcarrier spacing of Δf = 7.5 kHz is also possible. N_{BW}^{DL} can vary in order to allow for scalable bandwidth operation up to 20 MHz. Initially, the bandwidths for LTE were explicitly defined within layer 1 specifications. Later on a bandwidth agnostic layer 1 was introduced, with N_{BW}^{DL} for the different bandwidths to be specified by 3GPP RAN4 to meet performance requirements, e.g. for out-of-band emission requirements and regulatory emission limits.

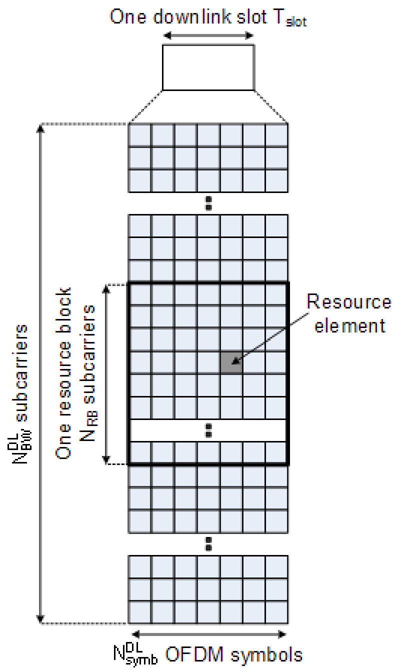


Fig. 3-5: Downlink Resource Grid

One downlink slot consists of N_{symb}^{DL} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 3-1. N_{symb}^{DL} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N_{symb}^{DL} = 7 symbols. This translates into a cyclic prefix length of T_{CP}≈5.2μs for the first symbol and T_{CP}≈4.7μs for the remaining 6 symbols. Additionally, an extended cyclic prefix is defined in order to cover large cell scenarios with higher delay spread and MBMS transmission. The generic frame structure with extended cyclic prefix of T_{CP-E}≈16.7μs contains N_{symb}^{DL} = 6 OFDM symbols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix of T_{CP-E}≈33.3µs contains N_{symb}^{DL} = 3 symbols (subcarrier spacing 7.5 kHz). table 3-1 gives an overview of the different parameters for the generic frame structure.

Table 3-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols N_{symb}^{DL}	Cyclic Prefix Length in Samples	Cyclic Prefix Length in µs
Normal cyclic prefix Δf=15 kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15 kHz	6	512	16.7 µs
Extended cyclic prefix Δf=7.5 kHz	3	1024	33.3 µs

3.1.2.3 Downlink Data Transmission

Data is allocated to the UEs in terms of resource blocks. A physical resource block consists of 12 (24) consecutive subcarriers in the frequency domain for the Δf=15 kHz (Δf=7.5 kHz) case. In the time domain, a physical resource block consists of DL N_{symb} consecutive OFDM symbols, see figure 3-5. N_{symb}^{DL} is equal to the number of OFDM symbols in a slot. The resource block size is the same for all bandwidths, therefore the number of available physical resource blocks depends on the bandwidth. Depending on the required data rate, each UE can be assigned one or more resource blocks in each transmission time interval of 1 ms. The scheduling decision is done in the base station (eNodeB). The user data is carried on the physical downlink shared channel (PDSCH). Downlink control signaling on the physical downlink control channel (PDCCH) is used to convey the scheduling decisions to individual UEs. The PDCCH is located in the first OFDM symbols of a slot.

3.1.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. figure 3-6 shows the principle of the downlink reference signal structure for one-antenna, two-antenna, and four-antenna transmission. Specific predefined resource elements in the time-frequency domain carry the reference signal sequence. Besides first reference symbols, there may be a need for second reference symbols. The different colors in figure 3-6 represent the sequences transmitted from up to four transmit antennas.

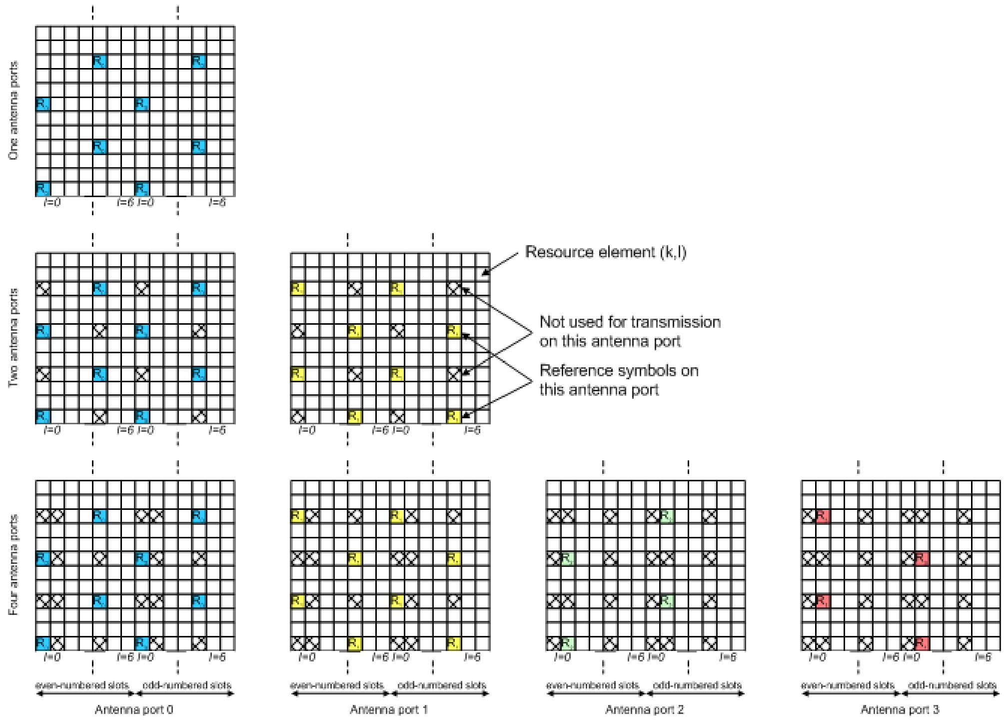


Fig. 3-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

The reference signal sequence carries the cell identity. Each reference signal sequence is generated as a symbol-by-symbol product of an orthogonal sequence r^{OS} (three of them existing) and a pseudo-random sequence r^{PRS} (170 of them existing). Each cell identity corresponds to a unique combination of one orthogonal sequence r^{OS} and one pseudo-random sequence r^{PRS}, allowing 510 different cell identities.

Frequency hopping can be applied to the downlink reference signals. The frequency hopping pattern has a period of one frame (10 ms).

During cell search, different types of information need to be identified by the handset: symbol and radio frame timing, frequency, cell identification, overall transmission bandwidth, antenna configuration, and cyclic prefix length.

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see figure 3-7.

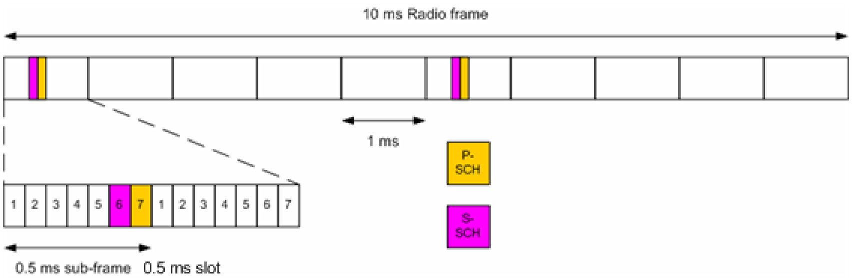


Fig. 3-7: P-SYNC and S-SYNC Structure

As additional help during cell search, a common control physical channel (CCPCH) is available which carries BCH type of information, e.g. system bandwidth. It is transmitted at predefined time instants on the 72 subcarriers centered around the DC subcarrier.

In order to enable the UE to support this cell search concept, it was agreed to have a minimum UE bandwidth reception capability of 20 MHz.

3.1.2.5 Downlink Physical Layer Procedures

For EUTRA, the following downlink physical layer procedures are especially important:

- **Cell search and synchronization**
  See above.
- **Scheduling**
  Scheduling is done in the base station (eNodeB). The downlink control channel PDCCH informs the users about their allocated time/frequency resources and the transmission formats to use. The scheduler evaluates different types of information, e.g. quality of service parameters, measurements from the UE, UE capabilities, and buffer status.
- **Link adaptation**
  Link adaptation is already known from HSDPA as adaptive modulation and coding. Also in EUTRA, modulation and coding for the shared data channel is not fixed, but rather is adapted according to radio link quality. For this purpose, the UE regularly reports channel quality indications (CQI) to the eNodeB.
- **Hybrid automatic repeat request (ARQ)**
  Downlink hybrid ARQ is also known from HSDPA. It is a retransmission protocol. The UE can request retransmissions of incorrectly received data packets.

3.2 EUTRA / LTE Test & Measurement Assumption made by Rohde & Schwarz

The following assumptions are valid for all current implementations on R&S signal generators and R&S signal analyzers.

OFDMA Parameterization

In order to configure the bandwidth of the signal to be generated and analyzed, the desired number of resource blocks can be specified in a range from 6 to 110 resource blocks with a granularity of 1. This results in bandwidths from 1.08 MHz…19.8 MHz.

The resulting FFT size is derived from the following formula:

$$N_{FFT} = 2^{nextpow2(\lceil 1.4\cdot(12n+1)\rceil)}$$

- n is the selected number of resource blocks
- nextpow2(N) returns the first P such that 2^P >= abs(N)
- ⌈ ⌉ rounds up to the next highest integer

3.3 Performing Time Alignment Measurements

The R&S FSVR-K102 provides the possibility to perform time alignment measurements between the different antennas for 2 or 4 TX antenna MIMO configurations. The time alignment error values represent the time offset between the considered antenna and antenna 1 and will be displayed in the result summary. The figure below shows a schematic description of the results.

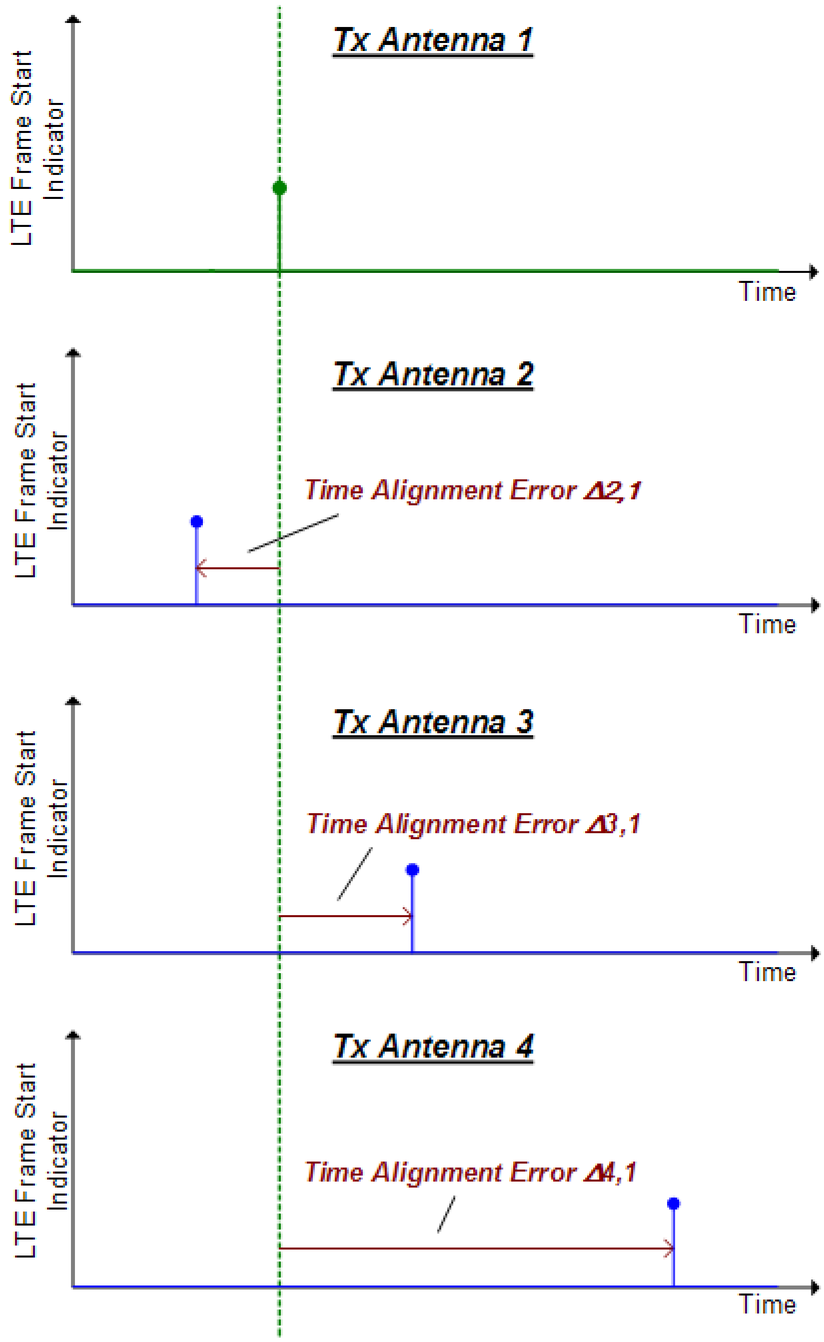


Fig. 3-8: Schematic description of the time alignment results

The figure below shows the test setup for the time alignment measurement (the dashed connections are only required for 4 TX antenna MIMO configuration). For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

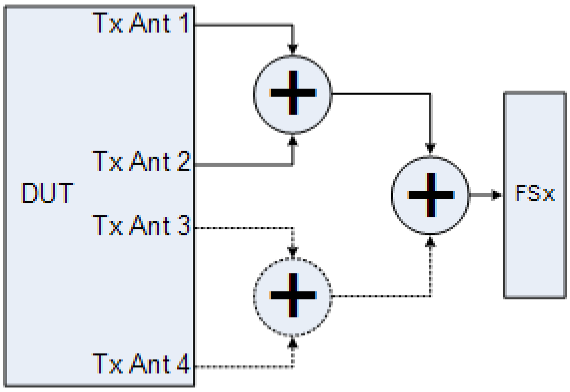
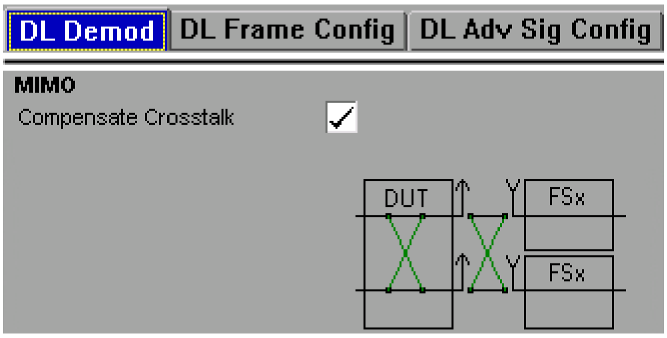


Fig. 3-9: Time alignment measurement hardware setup

For a successful time alignment measurement, make sure to set up the measurement correctly.

- the subframe selection in the general settings menu must be set to "All"
- enable "Compensate Crosstalk" in the demodulation settings, see screenshot below

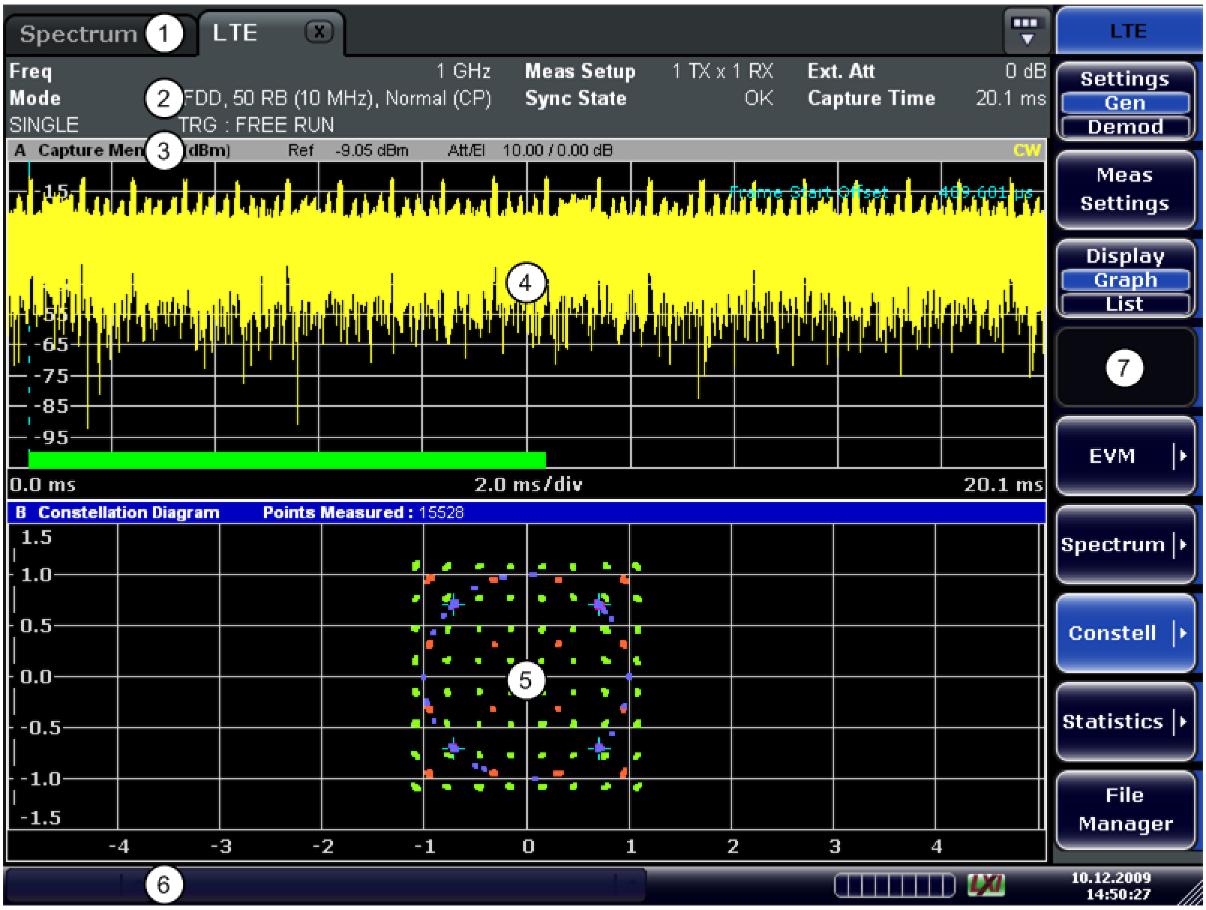


Note that the time alignment measurement only uses the reference signal and therefore ignores any PDSCH settings (e.g. it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing).

The EVM will usually be very high for this measurement. This does not effect the accuracy of the time alignment error measurement result.

4 Screen Layout

After starting the application, the screen takes on the following layout:



1 = Title Bar: shows the currently active measurement application
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the display trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays

Status Bar

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of Measurement Settings

The header table above the result display shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **Meas Setup**
  Shows number of transmitting and receiving antennas.
- **Sync State**
  The following synchronization states may occur:
  – **OK** The synchronization was successful.
  – **FAIL (C)** The cyclic prefix correlation failed.
  – **FAIL (P)** The P-SYNC correlation failed.
  – **FAIL (S)** The S-SYNC correlation failed.

  Any combination of C, P and S may occur.
  SCPI Command:
  `[SENSe]:SYNC[:STATe]` on page 112
- **Ext. Att**
  External attenuation in dB.
- **Capture Time**
  Capture length in ms.

5 Configuring Measurements

Before you can start a measurement, you have to configure the R&S FSVR in order to get valid measurement results. The following topics contain detailed information on all settings of the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns green to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns green.

In addition, you can set up general measurement parameters in the "Measurement Settings" dialog box. Special settings for SEM and ACLR measurements are provided by the corresponding dialog boxes.

5.1 General Settings

In the General Settings dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one. You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

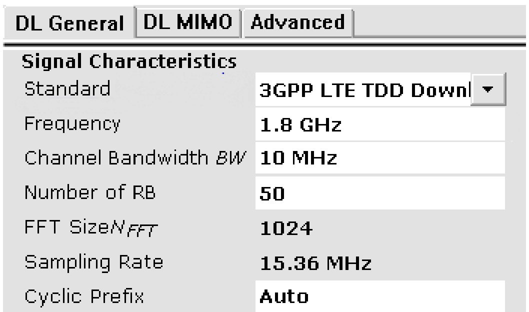
5.1.1 General

The "DL General" settings contain basic measurement and signal settings.

5.1.1.1 Signal Characteristics

Signal characteristics include settings to describe the basic physical attributes of the LTE signal.

You can find the signal characteristics in the "General Settings" dialog box.



Standard
The choices you have depend on the configuration of the R&S FSVR.

- option R&S FSVR-K100 enables testing of 3GPP LTE FDD signals on the downlink
- option R&S FSVR-K101 enables testing of 3GPP LTE FDD signals on the uplink
- option R&S FSVR-K104 enables testing of 3GPP LTE TDD signals on the downlink
- option R&S FSVR-K105 enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are duplexing methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the transmission path.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

SCPI command:

`CONFigure[:LTE]:LDIRection` on page 90

`CONFigure[:LTE]:DUPLexing` on page 89

Frequency

Sets the frequency of the signal and thus the center frequency of the R&S FSVR.

The available frequency range depends on the hardware configuration of the R&S FSVR you have in use.

The header table shows the current center frequency.

SCPI command:

`[SENSe]:FREQuency:CENTer` on page 110

Channel Bandwidth and Number of Resource Blocks

Specifies the channel bandwidth and the number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSVR automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

If you enter a value different to those recommended by the standard, the R&S FSVR labels the parameter as "User", but still does the calculations.

The R&S FSVR also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	23.04	30.72
FFT Size	128	256	512	1024	2048	2048

For more information on the calculation method of the FFT size see E-UTRA / LTE Test & Measurement Assumption made by Rohde & Schwarz.

SCPI command:

`CONFigure[:LTE]:DL:BW` on page 81

`CONFigure[:LTE]:DL:NORB` on page 83

Cyclic Prefix

The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

SCPI command:

`CONFigure[:LTE]:DL:CYCPrefix` on page 81

5.1.1.2 Level Settings

Level settings include general parameters necessary to adjust the R&S FSVR to the power level of the signal.

You can find the level settings in the "General Settings" dialog box.

Reference Level

Sets the reference level of the R&S FSVR.

The reference level is the power level the R&S FSVR expects at the RF input. Keep in mind that the power level at the RF input is the peak enevelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the R&S FSVR displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the RF reference level (in dBm) or baseband reference level (in V), depending on the input source.

You can also turn on automatic detection of the reference level with the "Auto Level" function.

If active, the R&S FSVR measures and sets the reference level to its ideal value before each sweep and makes sure that the results are accurate. However, measurement time will increase slightly. By default, the R&S FSVR automatically determines the measurement time, but you can define the measurement time of that measurement with the auto level track time.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual
CONFigure:POWer:EXPected:RF<analyzer> on page 90
Automatic
[SENSe]:POWer:AUTO<analyzer>[:STATe] on page 111

External Attenuation
Sets an external attenuation or gain.

If you attenuate or amplify the RF signal externally, the R&S FSVR adjusts the numeric and graphical results accordingly. In case of graphical power result displays, it moves the trace(s) vertically by the specified value.

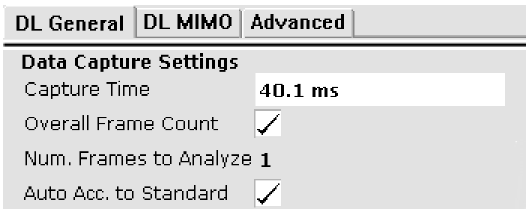
Positive values correspond to an attenuation and negative values correspond to an amplification.

SCPI command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 91

5.1.1.3 Configuring the Data Capture

Data capture includes all functionality that controls the amount and the way the R&S FSVR records the LTE signal data.

You can find the data capture settings in the "General Settings" dialog box.



Capture Time
Sets the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the R&S FSVR captures during one sweep.

SCPI command:
[SENSe]:SWEep:TIME on page 112

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep.

If the overall frame count is inactive, the R&S FSVR analyzes all complete LTE frames currently in the capture buffer.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 107

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSVR continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard (Auto According to Standard).

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 106

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSVR evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

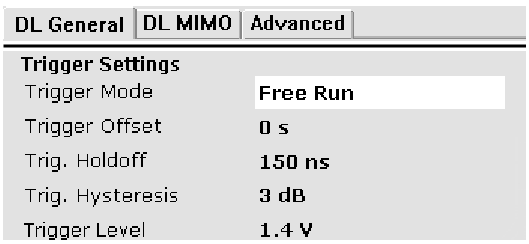
This parameter is not available if the overall frame count is inactive.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 106

5.1.1.4 Triggering Measurements

The trigger settings include all parameters necessary to describe conditions for triggering measurements.

You can find the trigger settings in the "General Settings" dialog box.



Trigger Mode
Selects the source that triggers a measurement.

The R&S FSVR supports several trigger modes.

- **Free Run**
  When Free Run is active, the measurement starts immediately.
- **External**
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- **IF Power**
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.
- **RF Power**
  The trigger event is the RF power level. The measurement starts when a signal outside of the measured channel meets or exceeds a certain level at the first intermediate frequency.
  The level range is from -50 dBm to -10 dBm. The corresponding trigger level at the RF input is:
  The RF Power trigger is available with detector board 1307.9554.02 Rev. 05.00 or higher. It is not available for measurements with the digital I/Q interface (R&S FSVR-B17).
- **Power Sensor**
  The trigger event is a specified level measured by a power sensor. The measurement starts when a power sensor measurement meets certain conditions.
  The power sensor as a trigger source is only available with option R&S FSVR-K9 and a connected power sensor.

SCPI command:
`TRIGger[:SEQuence]:MODE` on page 119

Trigger Offset
Specifies the delay between the trigger event and the start of the sweep. A negative trigger offset defines a pretrigger.

The trigger offset is unavailable for free run measurements.

SCPI command:
`TRIGger[:SEQuence]:HOLDoff<analyzer>` on page 119

Trigger Holdoff
Defines a trigger holdoff.

The trigger holdoff is the time that must pass after the trigger event and before the measurement starts.

The trigger holdoff is available for IF power and RF power triggers.

Trigger Hysteresis
Defines the trigger hysteresis.

The trigger hysteresis defines a distance to the trigger level that the input signal must stay below in order to fulfill the trigger condition.

Trigger Level
Specifies the trigger level for an external, IF, RF or power sensor trigger.

The name and contents of the field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

SCPI command:

`TRIGger[:SEQuence]:LEVel<analyzer>[:EXTernal]` on page 119

5.1.2 Advanced

The "Advanced" settings contain parameters to configure more complex measurement setups.

5.1.2.1 I/Q Settings

I/Q settings are all settings that define the way the R&S FSVR captures I/Q data.

You can find the I/Q settings in the "General Settings" dialog box.

Swap I/Q

Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

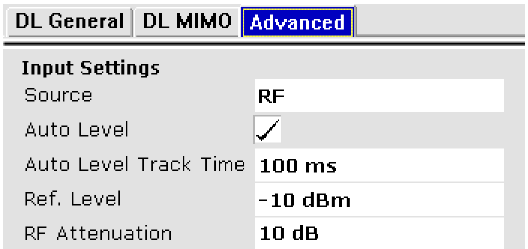
SCPI command:

`[SENSe]:SWAPiq` on page 112

5.1.2.2 Input Settings

The input settings provide all functions necessary to control the input source.

You can find the input settings in the "General Settings" dialog box.



Source

Selects the input source of the data.

By default, the R&S FSVR uses its RF input.

With hardware option R&S FSV-B17 you can use the digital baseband input. For more information on using digital baseband data see the manual of the R&S FSVR.

If the data has been recorded and saved already, you can also read the data from a file and analyze it on the R&S FSVR. For more information on how to import I/Q data see chapter 9, "File Management", on page 68.

SCPI command:
INPut:SELect on page 101

Reference Level
Sets the reference level of the R&S FSVR.

The reference level is the power level the R&S FSVR expects at the RF input. Keep in mind that the power level at the RF input is the peak enevelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the R&S FSVR displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the RF reference level (in dBm) or baseband reference level (in V), depending on the input source.

You can also turn on automatic detection of the reference level with the "Auto Level" function.

If active, the R&S FSVR measures and sets the reference level to its ideal value before each sweep and makes sure that the results are accurate. However, measurement time will increase slightly. By default, the R&S FSVR automatically determines the measurement time, but you can define the measurement time of that measurement with the auto level track time.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual
CONFigure:POWer:EXPected:RF<analyzer> on page 90
Automatic
[SENSe]:POWer:AUTO<analyzer>[:STATe] on page 111

RF Attenuation
Sets the mechanical attenuation of the RF signal at the RF input.

RF attenuation is independent of the reference level. It is in the range from 0 dB to 75 dB in steps of 5 dB.

RF attenuation is available if automatic reference level detection is inactive.

For more information on attenuation see the manual of the R&S FSVR.

SCPI command:
INPut<n>:ATTenuation<analyzer> on page 100

El Att

Configures the electronic attenuator.

The process of configuring the electronic attenuator consist of three steps.

- **Selecting the mode**
  You can select either manual or automatic control of the electronic attenuator.
- **Selecting the state**
  Turns the electronic attenuator on and off.
- **Setting the attenuation**
  Sets the degree of electronic attenuation.

If you have selected automatic attenuation mode, the R&S FSVR automatically calculates the electronic attenuation. State and degree of attenuation are not available in that case.

If you turn the attenuator off, the degree of attenuation is not available.

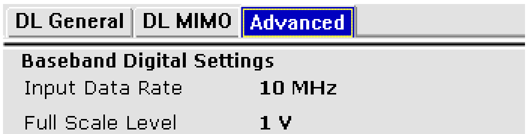
Electronic attenuation is available only with option R&S FSVR-B25 and if the frequency range does not exceed the specification of the electronic attenuator.

SCPI command:
`INPut:EATT:AUTO` on page 100

5.1.2.3 Digital I/Q Settings

The digital I/Q settings define settings related to the digital baseband input.

The digital baseband settings are available only if you have installed option R&S FSVR-B17.



Digital Input Data Rate

Selects the data sample rate at the digital baseband input.

The sample rate is available only if you have selected the digital baseband input source.

SCPI command:
`INPut<n>:DIQ:SRATe` on page 100

Full Scale Level

Sets the voltage corresponding to the maximum input value of the digital baseband input.

The full scale level is available only if you have selected the digital baseband input source.

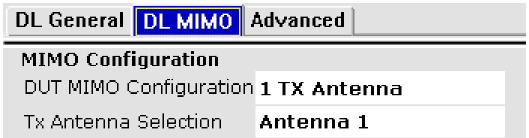
SCPI command:
`INPut<n>:DIQ:RANGe[:UPPer]` on page 100

5.1.3 MIMO

The "MIMO" settings control measurements in a MIMO setup.

5.1.3.1 MIMO Configuration

The MIMO Configuration parameters define essential settings related to the antenna configuration of a DUT.



DUT MIMO Configuration

Selects the number of transmission antennas of the DUT.

The application supports measurements on 1-, 2- and 4-antenna systems.

SCPI command:

CONFigure[:LTE]:DL:MIMO:CONFig on page 82

Tx Antenna Selection

Selects a specific antenna under test in case of MIMO systems.

The number of available antennas depends on the MIMO configuration.

SCPI command:

CONFigure[:LTE]:DL:MIMO:ASELection on page 82

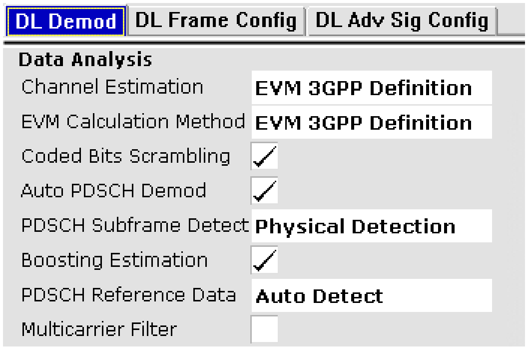
5.2 Demodulation Settings for Downlink Measurements

In the Demod Settings dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one. You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

5.2.1 DL Demod

In the DL Demod tab you can set the signal processing configuration with respect to how the signal is to be measured.

5.2.1.1 Data Analysis Settings



Channel Estimation

Selects the method of channel estimation.

- **EVM 3GPP Definition**
  Channel estimation according to 3GPP TS 36.141. This method is based on averaging in frequency direction and linear interpolation. Examines the reference signal only.
- **Optimal, Pilot only**
  Optimal channel estimation method. Examines the reference signal only.
- **Optimal, Pilot and Payload**
  Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:CESTimation` on page 108

EVM Calculation Method

Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**
  Calculates the EVM using the optimal timing position.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:EVMCalc` on page 108

Scrambling of Coded Bits

Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:CBSCrambling` on page 107

Auto PDSCH Demodulation

Turns automatic demodulation for the PDSCH on and off.

If active, the R&S FSVR automatically detects the PDSCH resource allocation by analyzing the signal or the protocol information in the PDCCH.

You can set the way the R&S FSVR identifies the resource allocation with PDSCH Subframe Configuration Detection.

SCPI command:
[SENSe][:LTE]:DL:DEMod:AUTO on page 107

PDSCH Subframe Configuration Detection
Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
  If manual PDSCH configuration is active, the R&S FSVR compares the demodulated LTE frame to the user configuration. Only if both configurations are the same, the R&S FSVR will analyze the frame.
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.
  If automatic detection of the PDSCH configuration is active, the R&S FSVR identifies the configuration from the modulation of the signal.

SCPI command:
[SENSe][:LTE]:DL:FORMat:PSCD on page 109

Boosting Estimation
Turns boosting estimation on and off.

If active, the R&S FSVR automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

SCPI command:
[SENSe][:LTE]:DL:DEMod:BESTimation on page 107

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

- Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector.
  This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

SCPI command:
[SENSe][:LTE]:DL:DEMod:PRData on page 108

Multicarrier Filter

Turns the suppression of interference of neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

SCPI command:

`[SENSe][:LTE]:DL:DEMod:MCFilter` on page 108

5.2.1.2 Tracking

Phase

Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

- **Off**
  Phase tracking is not applied.
- **Pilot only**
  Only the reference signal is used.
- **Pilot and Payload**
  Both reference signal and payload resource elements are used.

SCPI command:

`[SENSe][:LTE]:DL:TRACking:PHASe` on page 109

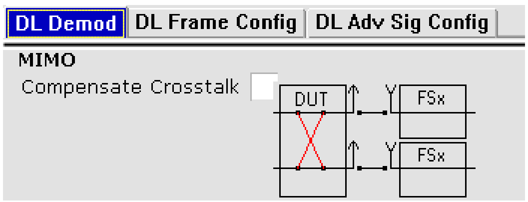
Timing

Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

SCPI command:

`[SENSe][:LTE]:DL:TRACking:TIME` on page 110

5.2.1.3 MIMO Settings



Compensate Crosstalk

Specifies if crosstalk produced by the device under test will be compensated or not. The crosstalk compensation must be activated for Time Alignment Error measurements.

SCPI command:

`CONFigure[:LTE]:DL:MIMO:CROSstalk` on page 82

5.2.2 DL Frame Config

In the DL Frame Config tab you can set the structure of the signal.

5.2.2.1 Configuring TDD Frames

Note that you need firmware application R&S FSV-K104 to perform measurements on TDD signals.

Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink

D = downlink

S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS

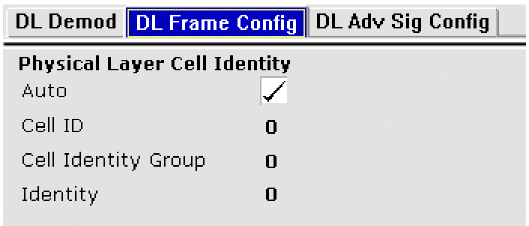
The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.

- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:
Subframe
`CONFigure[:LTE]:DL:TDD:UDConf` on page 89
Special Subframe
`CONFigure[:LTE]:DL:TDD:SPSC` on page 89

5.2.2.2 Configuring the Physical Layer Cell Identity



Configuring the Physical Layer Cell Identity
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSVR automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is contained in the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is contained in the S-SYNC.

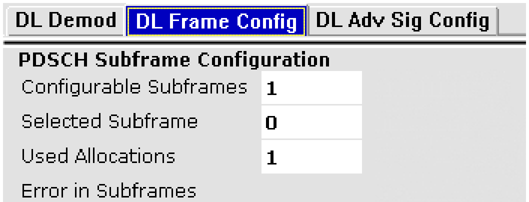
In addition to the synchronization information, the cell ID also determines

- the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
- the frequency shifts of the reference signal.

5.2.2.3 Configuring PDSCH Subframes

The application allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

If you turn "Auto Demodulation" on, the appplication automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.



Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The R&S FSVR shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	Number of RB	Offset RB	Rho A (Power)/dB	Confl.
0	1/1	QPSK	6	0	0 dB	

If there are any errors or conflicts between allocations in one or more subframes, the R&S FSVR shows the number of errors and the number of the corrupt subframe in the "Error in Subframes" field. It does not show the kind of error.

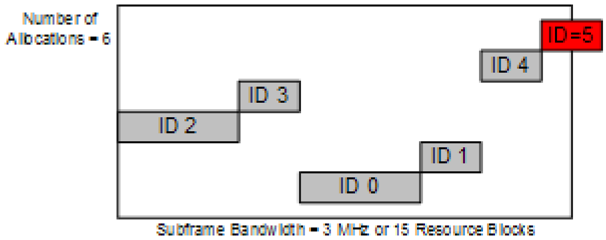
Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 40 subframes.

Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The R&S FSVR will update the contents of the configuration table to the selected subframe.

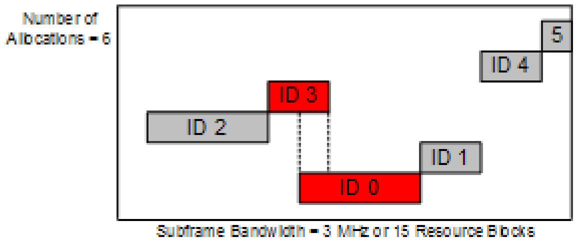
In the default state, each subframe contains one allocation. You can add allocations with the "Used Allocations" parameter. The R&S FSVR will expand the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 100 allocations in every subframe.

The configuration table contains the settings to configure the allocations.

- ID/N_RNTI
  Selects the allocation's ID. The ID corresponds to the N_RNTI.
  By default, the application assigns consecutive numbers starting with 0.
  The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant.
  You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- Code Word
  Shows the code word of the allocation.
  The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation includes. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.
- Modulation
  Selects the modulation scheme for the corresponding allocation.
  The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- Number of RB
  Sets the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.
  If you allocate too many resource blocks compared to the bandwidth you have set, the R&S FSVR will show an error message in the "Conflicts" column and the "Error in Subframes" field.
- Offset RB
  Sets the resource block at which the allocation begins.
  A wrong offset for any allocation would lead to an overlap of allocations. In that case the R&S FSVR will show an error message.
- Power [dB]
  Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- Conflict
  If there is a conflict between allocations in the displayed subframe, this column shows the type of conflict and the ID of the allocations that are affected. Possible errors are:
  – bandwidth error (">BW")
    A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



– RB overlap errors
  An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



SCPI command:
Configurable Subframes
`CONFigure[:LTE]:DL:CSUBframes` on page 81
Used Allocations
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount` on page 87
Modulation
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation` on page 88
Number of RB
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount` on page 87
Offset RB
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset` on page 87
Power
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer` on page 87

5.2.3 DL Advanced Signal Configuration

In the DL Adv Sig Config tab you can describe the advanced structure of the signal.

Note that the power settings of the channels are in relation to the power of the reference signal.

5.2.3.1 Global Settings

PRB Symbol Offset
PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data then overwrite some resource elements of the PDSCH.

SCPI command:
`CONFigure[:LTE]:DL:PSOFfset` on page 86

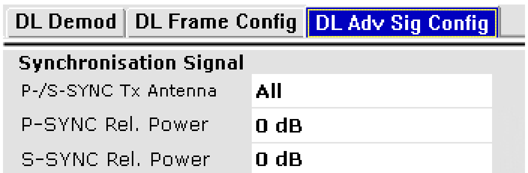
5.2.3.2 Defining the Structure of the Reference Signal

Rel Power
Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

Note that this setting gives you an offset to all other relative power settings.

SCPI command:
`CONFigure[:LTE]:DL:REFSig:POWer` on page 86

5.2.3.3 Configuring the Synchronization Signal



P-/S-SYNC Tx Antenna
Selects the antenna that transmits the P-SYNC and the S-SYNC.

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the R&S FSVR uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:ANTenna` on page 88

P-SYNC Relative Power
Relative power of the P-SYNC signals.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:PPOWer` on page 88

S-SYNC Relative Power
Relative power of the S-SYNC signals.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:SPOWer` on page 88

5.2.3.4 Configuring the PBCH

Present
PBCH Present specifies whether the physical broadcast channel is present or not.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:STAT` on page 83

Rel Power
Relative Power of the PBCH.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:POWer` on page 83

5.2.3.5 Configuring the PCFICH

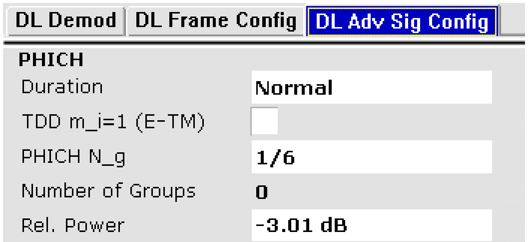
Present
PCFICH Present specifies whether the physical control format channel is present or not.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:STAT` on page 84

Rel Power
Relative Power of the PCFICH.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:POWer` on page 83

5.2.3.6 Configuring the PHICH



Duration
Selects the duration of the PHICH. Normal and extended duration are supported.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:DURation` on page 84

TDD m_i=1 (E-TM)
Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:MITM` on page 85

PHICH N_g
Sets the variable N_g.

N_g in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N_g that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with Number Of Groups.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NGParameter` on page 85

Number Of Groups
Sets the number of PHICH groups contained in a subframe.

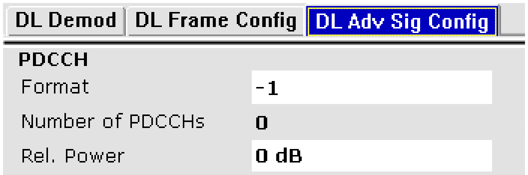
To select a number of groups, you have to set the PHICH N_g to "Custom".

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 85

Rel Power
Relative Power of the PHICH.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 86

5.2.3.7 Configuring the PDCCH



PDCCH Format

Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

SCPI command:

`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 84

Number Of PDCCH

Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

SCPI command:

`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 84

Rel Power

Relative Power of the PDCCH.

SCPI command:

`CONFigure[:LTE]:DL:PDCCh:POWer` on page 84

5.3 Measurement Settings

The Measurement Settings are for setting up the result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box via the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one. You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

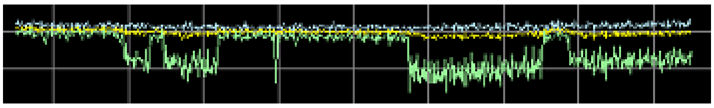
5.3.1 Selection

In the Selection tab you can select specific parts of the signal you want to analyze.

Subframe Selection
With the Subframe Selection, subframe-specific measurement results can be selected. This setting applies to the following measurements: Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation diagram, Allocation Summary list and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Example

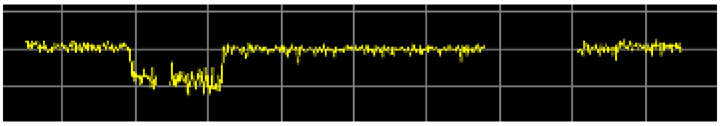
If you select --All---, the R&S FSVR shows the minimum / mean / maximum statistic.



with AV MI PK

- PK: peak value
- AV: average value
- MI: minimum value

If you instead select a specific subframe, the R&S FSVR shows only the results of that subframe.



SCPI command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 110

5.3.2 Units

In the Units tab you can define the unit for various measurements.

EVM Unit
The EVM Unit setting allows you to display EVM results in the graphs and the numerical results in dB or %.

SCPI command:
`UNIT:EVM` on page 120

5.3.3 Misc

In the Misc tab you can set miscellaneous parameters.

Bit/Symbols Format
The Bit/Symbols Format setting allows you to display the bit stream as symbols (the bits belonging to one symbol are shown as hexadecimal numbers, always with two digits) or raw bits.

Examples:

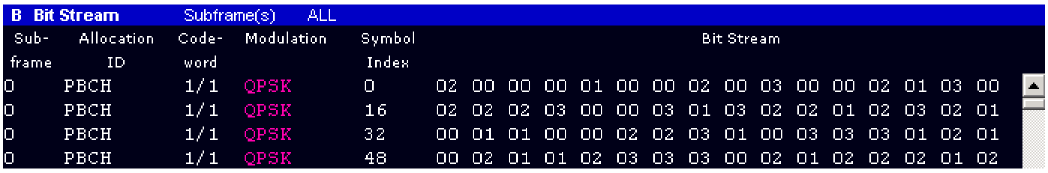


Fig. 5-1: Bit stream display in downlink application if the bit stream format is set to "symbols"

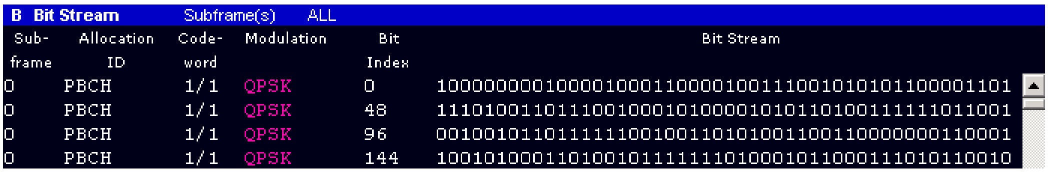


Fig. 5-2: Bit stream display in downlink application if the bit stream format is set to "bits"

SCPI command:
UNIT:BSTR on page 120

5.4 ACLR Settings

The ACLR Settings are parameters for configuring the Adjacent Channel Leakage Ratio measurement.

Assumed Adjacent Channel Carrier

Selects the assumed adjacent channel carrier for the ACLR measurement. The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

SCPI command:
[SENSe]:POWer:ACHannel:AACHannel on page 110

Noise Correction

Turns noise correction on and off.

For more information see the manual of the R&S FSVR.

Note that the input attenuator makes a clicking noise after every sweep if you are using the noise correction in combination with the auto leveling process.

SCPI command:
[SENSe]:POWer:NCORrection on page 112

5.5 SEM Settings

The SEM Settings are parameters for configuring the Spectrum Emission Mask measurement.

Channel
Selects the Category (A or B) to be used for the Spectrum Emission Mask measurement.

SCPI command:
`[SENSe]:POWer:SEM:CATegory` on page 112

5.6 Display and Printer Settings

The layout of the display can be controlled using the display menu. The DISP key opens the display softkey menu.

In the display menu, you can switch between split and full screen mode with the "Screen Size" softkey. In split screen mode, you can select screen A or screen B with the "Screen A" / "Screen B" hotkey. The "Screen A" / "Screen B" hotkey also toggles screen A and B in full screen mode.

The HCOPY key opens the print menu. Any open settings dialog boxes are closed when the print menu is displayed.

The print functions are the same as those provided in the base unit. Refer to the operating manual of the R&S FSVR for details on the softkey functionality.

6 Result Displays

This chapter provides a detailed description of all available result displays of the LTE measurement application.

Press the MEAS key to access the result display menu. There you can select the required result display by pressing the corresponding softkey.

Note that some softkeys include more than one result display. The currently selected result display is highlighted on the corresponding softkey.

6.1 Numerical Results

In addition to graphical result displays, the R&S FSVR also provides a table containing numerical results. You can switch between numerical and graphical results with the "Display (List Graph)" softkey.

Display (List Graph)
Press the Display (List Graph) softkey so that the "List" element turns green to start the Result Summary result display. This result display summarizes all relevant measurement results in one table.

Result Summary						
Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK		0.35	17.50			%
EVM PDSCH 16QAM			12.50			%
EVM PDSCH 64QAM			8.00			%
Time Alignment Error 2,1						ns
Time Alignment Error 3,1						ns
Time Alignment Error 4,1						ns
Results for Selection	Subframe(s) ALL	Selection Antenna 1		Frame Result 1/1		
EVM All	0.34	0.35		0.36		%
EVM Phys. Channel	0.34	0.35		0.36		%
EVM Phys. Signal	0.33	0.35		0.36		%
Frequency Error	- 35.44	- 35.36		- 35.26		Hz
Sampling Error	- 0.07	- 0.04		- 0.01		ppm
IQ Offset	- 68.33	- 67.16		- 66.53		dB
IQ Gain Imbalance	- 0.00	- 0.00		- 0.00		dB
IQ Quadrature Error	0.02	0.02		0.02		°
RSTP	- 57.96	- 57.95		- 57.95		dBm
OSTP	- 30.17	- 30.17		- 30.17		dBm
Power	- 30.25	- 30.23		- 30.22		dBm
Crest Factor		10.05				dB

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also provides limit checking for result values in accordance with the selected standard. 'Pass' results are green and 'Fail' results are red.

- **EVM PDSCH QPSK**

Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame.
FETCh:SUMMary:EVM:DSQP[:AVERage] on page 93

- **EVM PDSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:DSST[:AVERage] on page 93
- **EVM PDSCH 64QAM**
  Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:DSSF[:AVERage] on page 93
- **Time Alignment Error 2,1 / 3,1 / 4,1**
  Shows the timing difference in MIMO setups between antenna 1 and another antenna (2, 3 or 4).
  FETCh:SUMMary:TAE<antenna> on page 98

By default, all EVM results are in %. However, you can change the EVM unit in the EVM Unit field.

The second part of the table shows results that refer to a specifc selection of the frame. The header row of the second section of the table shows the selected subframe.

Note that in some cases it is not possible to measure the IQ Gain Imbalance and IQ Quadrature Error. Try to step through the subframes using the Subframe Selection to find a subframe where the measurement is available. If subframe selection is set to "All", a measurement result is available only if there are valid results in all subframes.

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  FETCh:SUMMary:EVM[:ALL][:AVERage] on page 94
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PCHannel[:AVERage] on page 94
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PSIGnal[:AVERage] on page 94
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  FETCh:SUMMary:FERRor[:AVERage] on page 95
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  FETCh:SUMMary:SERRor[:AVERage] on page 97
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  FETCh:SUMMary:IQOFfset[:AVERage] on page 96
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage] on page 95
- **I/Q Quadrature Error**

Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
`FETCh:SUMMary:QUADerror[:AVERage]` on page 97

- **RSTP**
  Shows the reference signal transmit power as defined in 3GPP TS 36.141.
  `FETCh:SUMMary:RSTP[:AVERage]` on page 97
- **OSTP**
  Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
  `FETCh:SUMMary:OSTP[:AVERage]` on page 96
- **Power**
  Shows the average time domain power of the analyzed signal.
  `FETCh:SUMMary:POWer[:AVERage]` on page 96
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  `FETCh:SUMMary:CRESt[:AVERage]` on page 93

6.2 Power vs Time Result Displays

This chapter contains information on LTE result displays that show the power of the signal over time.

Capture Memory
The capture memory result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input) or V (base-band input).

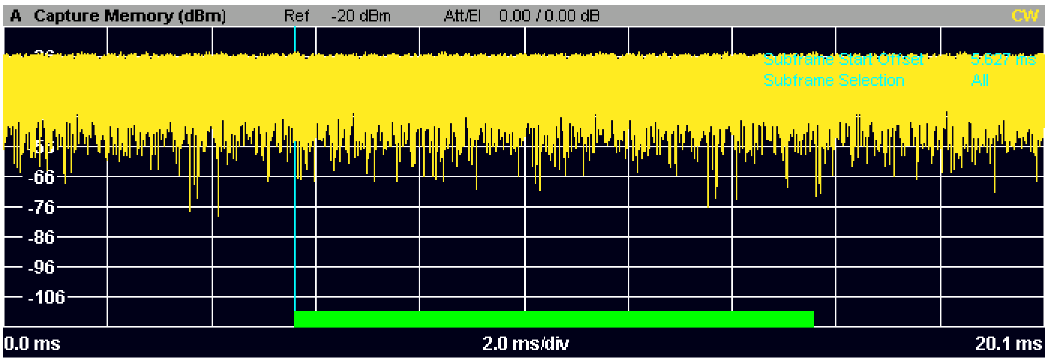


Fig. 6-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently ana-lyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the graph includes the Subframe Start Offset value (blue text). This value is the time difference between the subframe start and capture buffer start.

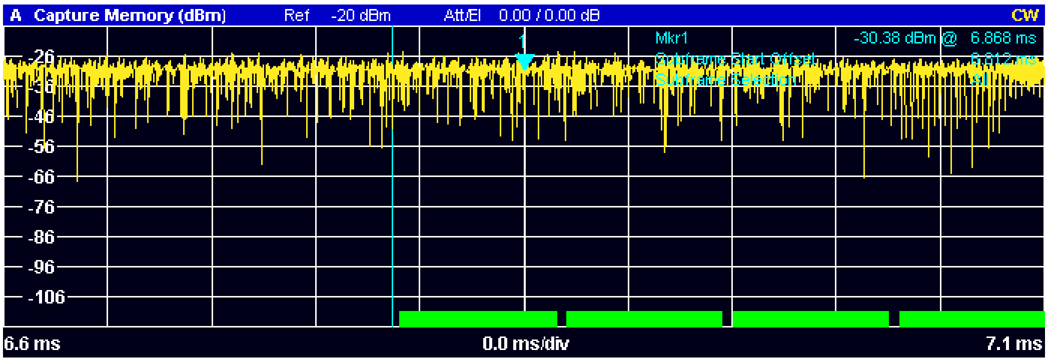


Fig. 6-2: Capture buffer after a zoom has been applied

CALCulate<screenid>:FEED 'PVT:CBUF'

6.3 EVM Results

One of the most important results to determine the quality of a signal is the Error Vector Magnitude or EVM. Refer to chapter 10.1, "Measurements in Detail", on page 70 for details on the mathematical foundations of the EVM measurement.

The R&S FSVR EUTRA/LTE Measurement Application offers various result displays to determine the EVM of the signal on different levels.

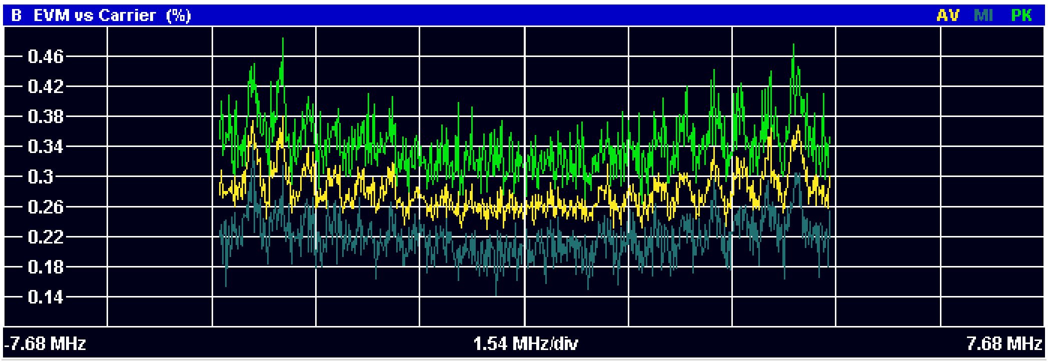
EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

The displayed result is an average over all available OFDM symbols. By default, three traces are shown. One trace shows the average EVM. The second and the third trace show the minimum and maximum EVM values respectively. You can select to display the EVM for a specific subframe. In that case, the application shows the EVM of that subframe only.

For more information seechapter 5.3.1, "Selection", on page 45 .

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



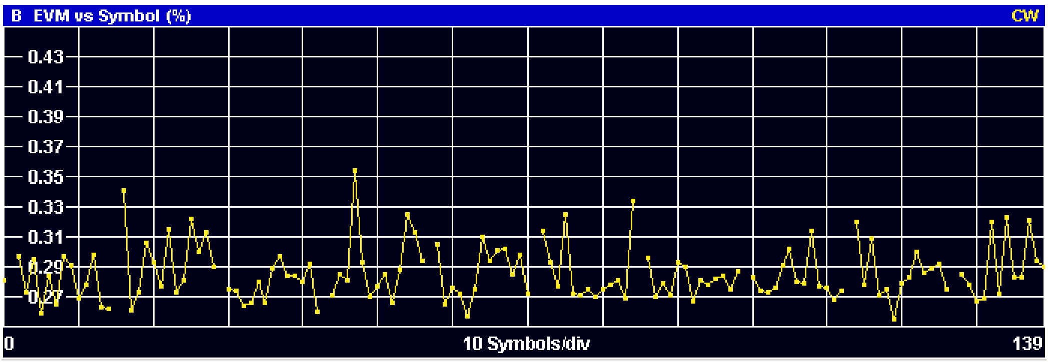
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVCA'

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) on symbol level. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSVR could not determine the EVM for that symbol. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



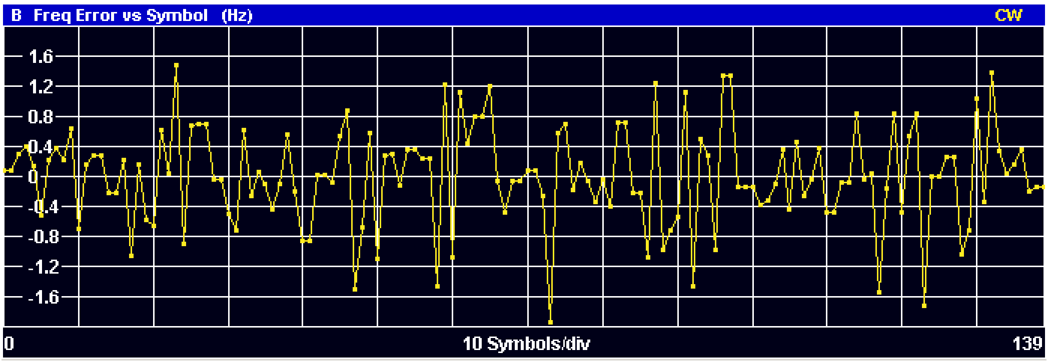
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVSY'

Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSVR could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.



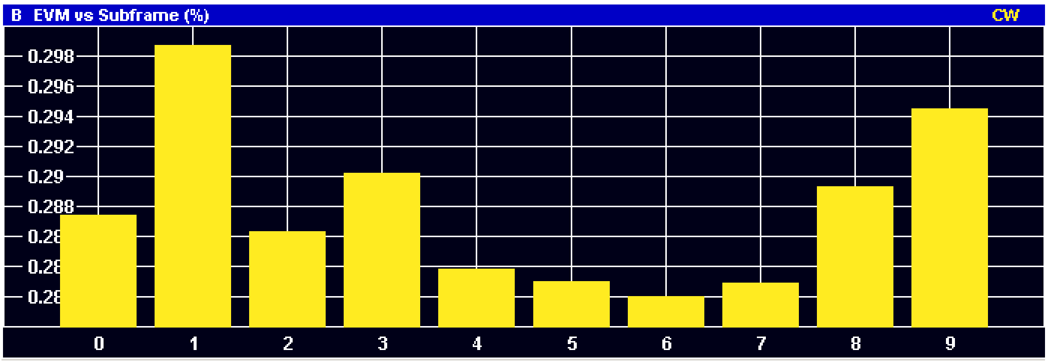
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVVS'

EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



SCPI command:
CALCulate<screenid>:FEED 'EVM:EVSU'

6.4 Spectrum Measurements

This chapter contains the spectrum measurements. Spectrum measurements are separated into the frequency sweep measurements and I/Q measurements.

6.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available with the R&S FSVR EUTRA/LTE Measurement Application. They do not use the IQ data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an IQ measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurement use different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

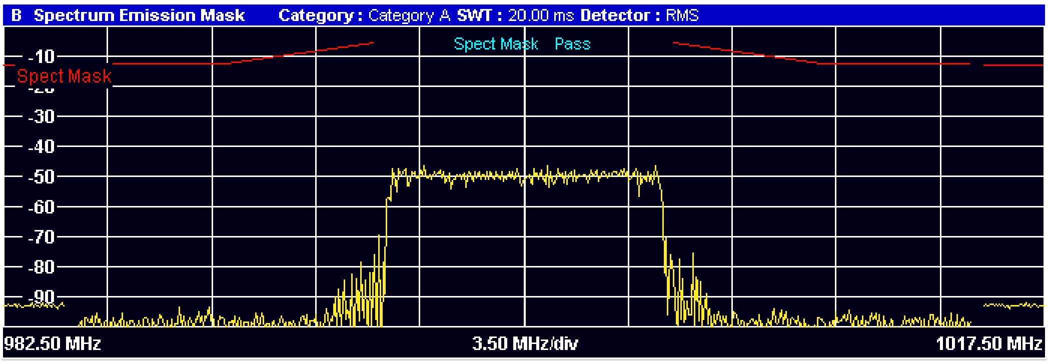
The ACLR and SEM measurements are available if RF input is selected.

Spectrum Emission Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSVR puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**

Shows the absolute power at the frequency whose power measurement being closest to the limit line; for the corresponding frequency segment.

- **Power Rel**
  Shows the power relative to the Reference Power at the frequency closest to the limit line; for the corresponding frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

A Spectrum Emission Mask List Ref -26.2 dBm Att/El 0.00 / 0.00 dB

Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Power Abs.	Power Rel.	Δ to Limit
-17.50 MHz	-15.50 MHz	1.00 MHz	983.453504000 MHz	-92.05 dBm	-61.65 dB	-79.05 dB
-15.05 MHz	-10.05 MHz	100.00 kHz	989.399040000 MHz	-93.46 dBm	-63.05 dB	-80.96 dB
-10.05 MHz	-5.05 MHz	100.00 kHz	994.950016000 MHz	-75.77 dBm	-45.37 dB	-70.27 dB
5.05 MHz	10.05 MHz	100.00 kHz	1.005665088 GHz	-75.44 dBm	-45.03 dB	-69.08 dB
10.05 MHz	15.05 MHz	100.00 kHz	1.010937472 GHz	-94.43 dBm	-64.03 dB	-81.93 dB
15.50 MHz	17.50 MHz	1.00 MHz	1.016883008 GHz	-92.15 dBm	-61.74 dB	-79.15 dB

SCPI command:
CALCulate<screenid>:FEED 'SPEC:SEM'

ACLR

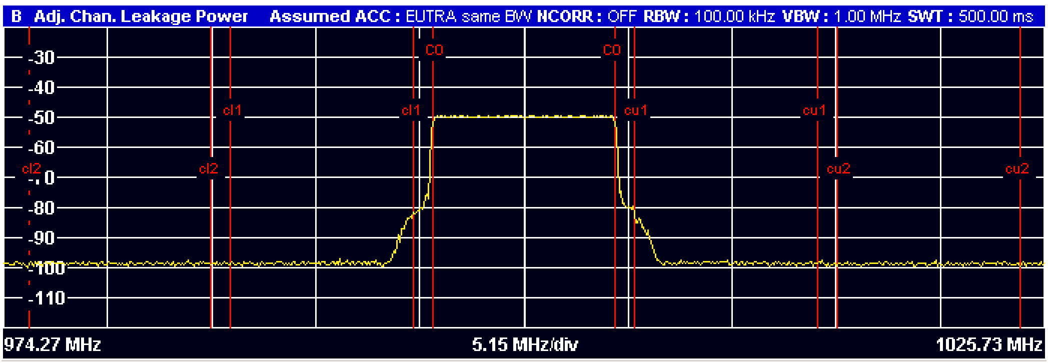
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

By default the ACLR Settings are derived from the LTE Channel Bandwidth setting of the Demodulation Settings Panel. You can change the assumed adjacent channel carrier type and the noise correction via the ACLR Settings.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

A **Adj. Chan. Leakage Power Ratio List** Ref -26.2 dBm Att/El 0.00 / 0.00 dB

Channel	Bandwidth	Spacing	Lower	Upper	Limit
TX	9.015 MHz	...	-30.53 dB		...
Adjacent	9.015 MHz	10.00 MHz	-44.30 dB	-44.72 dB	-45.00 dB
Alternate	9.015 MHz	20.00 MHz	-48.75 dB	-48.88 dB	-45.00 dB

SCPI command:
CALCulate<screenid>:FEED 'SPEC:ACP'

6.4.2 I/Q Result Displays

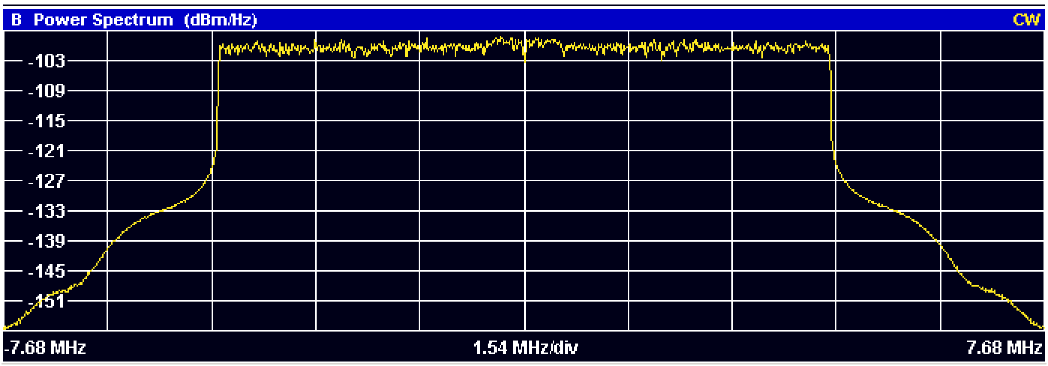
Power (Spec RB_RS RB_PDSCH)
The Power (Spec RB_RS RB_PDSCH) softkey selects one of three result displays. The currently selected result display is highlighted.

Power Spectrum ← Power (Spec RB_RS RB_PDSCH)
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth and Number of Resource Blocks" on page 25.

The x-axis represents the frequency. On the y-axis the power level is plotted.



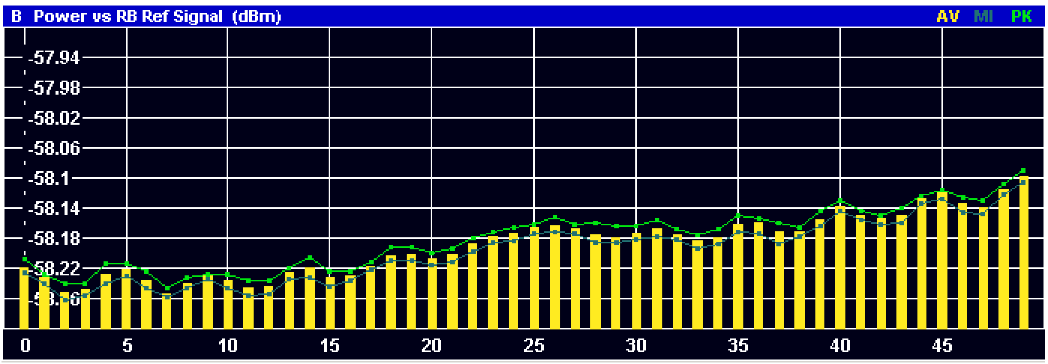
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PSPE'

Power vs Resource Block RS ← Power (Spec RB_RS RB_PDSCH)
Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



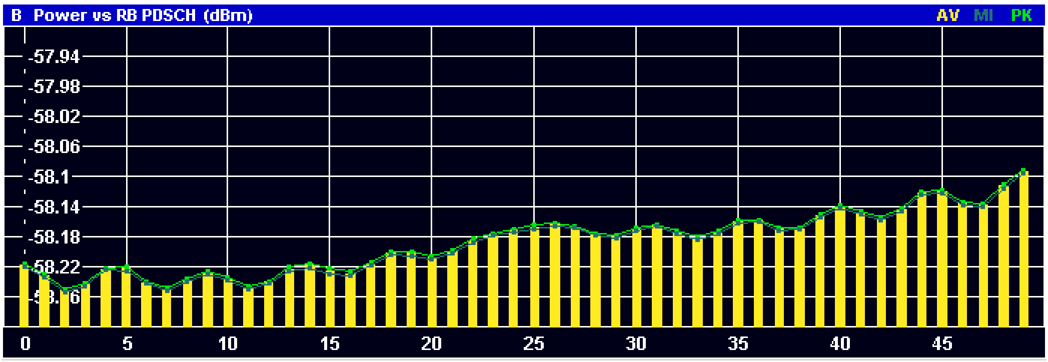
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRR'

Power vs Resource Block PDSCH ← Power (Spec RB_RS RB_PDSCH)
Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRP'

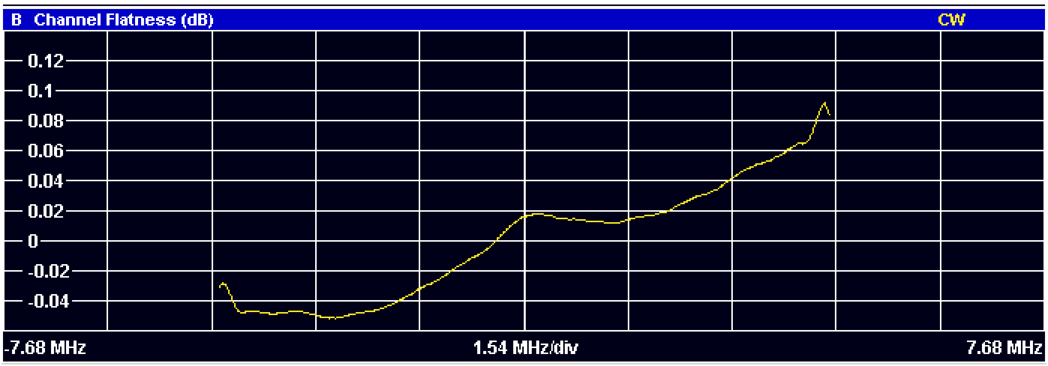
Flatness (Flat Grdel Diff)
The Flatness (Flat Grdel Diff) softkey selects one of three result displays. The currently selected result display is highlighted.

Channel Flatness ← Flatness (Flat Grdel Diff)
Starts the Channel Flatness result display.

This result display shows the amplitude of the channel transfer function.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



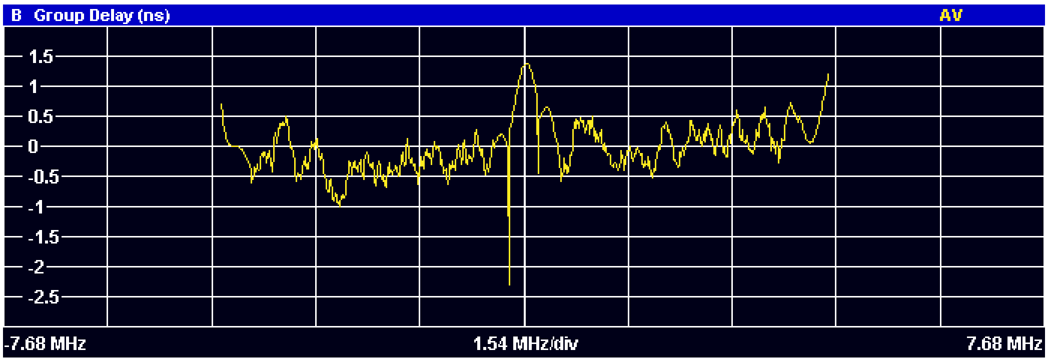
SCPI command:
CALCulate<screenid>:FEED 'SPEC:FLAT'

Channel Group Delay ← Flatness (Flat Grdel Diff)
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



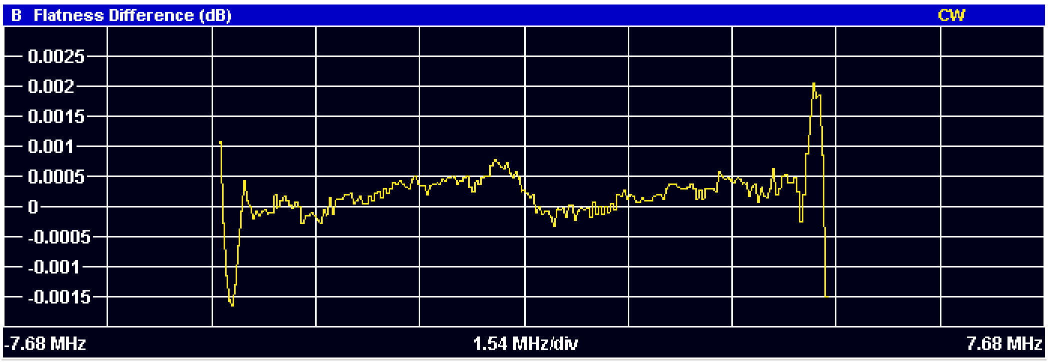
SCPI command:
CALCulate<screenid>:FEED 'SPEC:GDEL'

Channel Flatness Difference ← Flatness (Flat Grdel Diff)
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



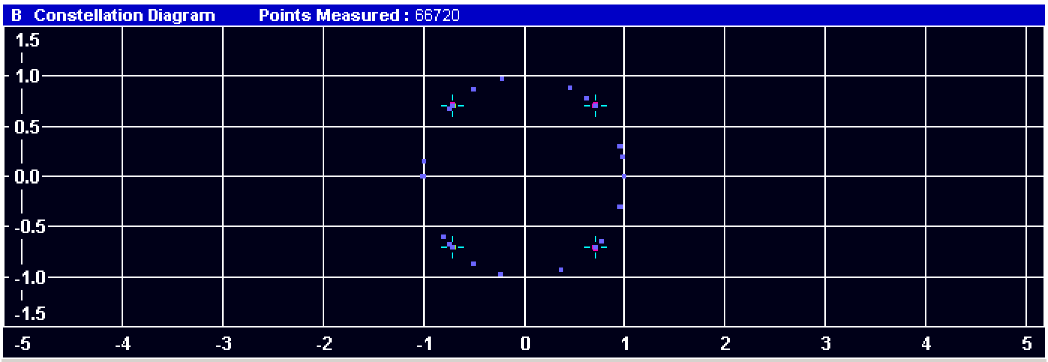
SCPI command:
CALCulate<screenid>:FEED 'SPEC:FDIF'

6.5 Constellation Diagrams

Constellation Diagram
Starts the Constellation Diagram result display.

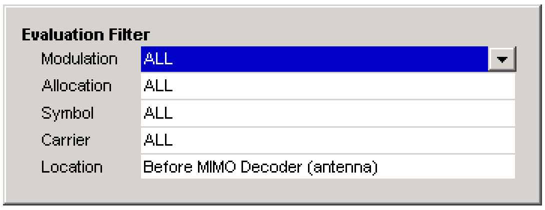
This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.



SCPI command:
CALCulate<screenid>:FEED 'CONS:CONS'

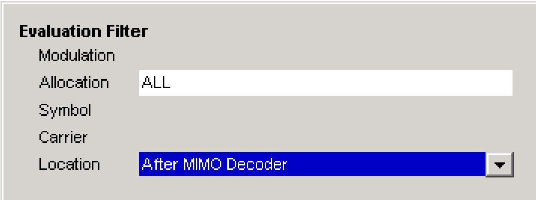
Constellation Selection
Opens a dialog box to filter the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.



You can filter the results by the following parameters:

- **Modulation**
  Filter by modulation scheme.
- **Allocation**
  Filter by allocation ID.
- **Symbol**
  Filter by OFDM symbol.
- **Carrier**
  Filter by subcarrier.
- **Location**
  Selects whether the R&S FSVR generates the constellation diagram before or after the MIMO decoder.
  If you use Spatial Multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. Filter these symbols in the field "Modulation" with the value "MIXTURE". You get the mixed symbols only if "Location" is set to "Before MIMO decoder".

If the location is "After MIMO Decoder", filters "Symbol" and "Carrier" are not available.



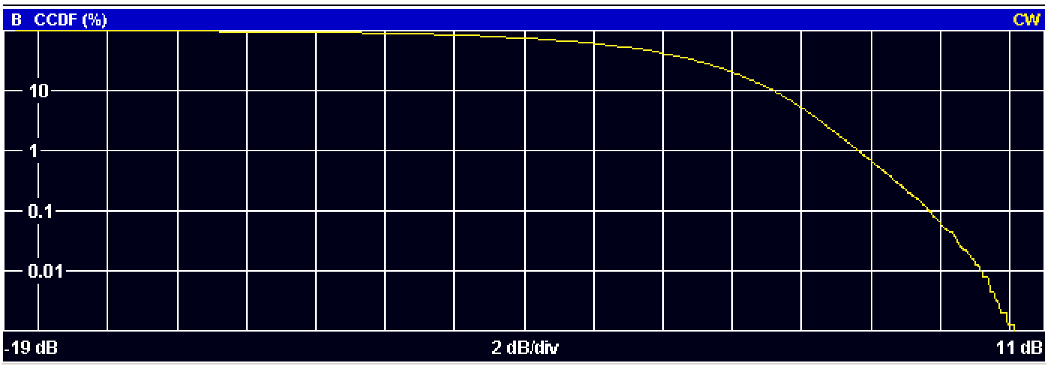
6.6 Statistical and Miscellaneous Results

CCDF

Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



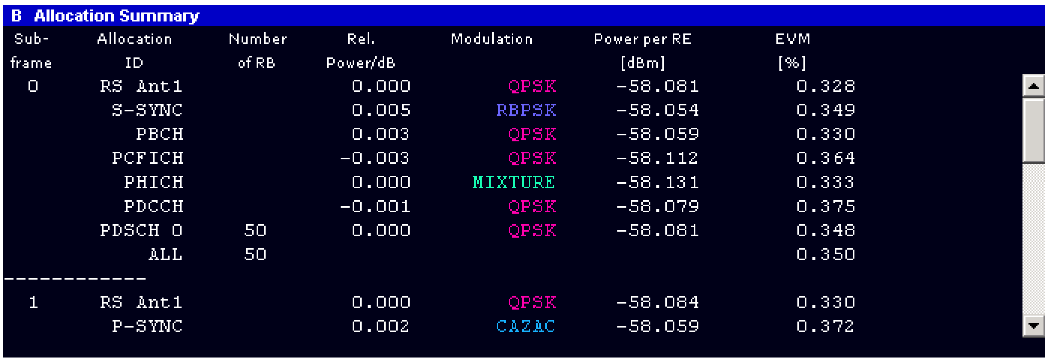
SCPI command:

CALCulate<screenid>:FEED 'STAT:CCDF'

Allocation Summary

Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.



B Allocation Summary

Sub-frame	Allocation ID	Number of RB	Rel. Power/dB	Modulation	Power per RE [dBm]	EVM [%]
0	RS Ant1		0.000	QPSK	-58.081	0.328
	S-SYNC		0.005	RBPSK	-58.054	0.349
	PBCH		0.003	QPSK	-58.059	0.330
	PCFICH		-0.003	QPSK	-58.112	0.364
	PHICH		0.000	MIXTURE	-58.131	0.333
	PDCCH		-0.001	QPSK	-58.079	0.375
	PDSCH 0	50	0.000	QPSK	-58.081	0.348
	ALL	50				0.350

1	RS Ant1		0.000	QPSK	-58.084	0.330
	P-SYNC		0.002	CAZAC	-58.059	0.372

The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.
- **EVM**
  Shows the EVM of the allocation. You can change the unit of the EVM in the Measurement Settings dialog box.

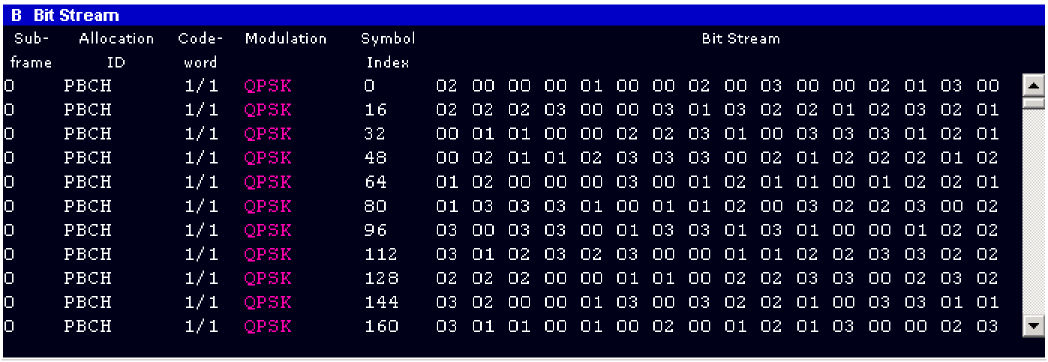
SCPI command:
CALCulate<screenid>:FEED 'STAT:ASUM'

Bit Stream

Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit/Symbols Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.



B Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	02 00 00 00 01 00 00 02 00 03 00 00 02 01 03 00
0	PBCH	1/1	QPSK	16	02 02 02 03 00 00 03 01 03 02 02 01 02 03 02 01
0	PBCH	1/1	QPSK	32	00 01 01 00 00 02 02 03 01 00 03 03 03 01 02 01
0	PBCH	1/1	QPSK	48	00 02 01 01 02 03 03 03 00 02 01 02 02 02 01 02
0	PBCH	1/1	QPSK	64	01 02 00 00 00 03 00 01 02 01 01 00 01 02 02 01
0	PBCH	1/1	QPSK	80	01 03 03 03 01 00 01 01 02 00 03 02 02 03 00 02
0	PBCH	1/1	QPSK	96	03 00 03 03 00 01 03 03 01 03 01 00 00 01 02 02
0	PBCH	1/1	QPSK	112	03 01 02 03 02 03 00 00 01 01 02 02 03 03 02 02
0	PBCH	1/1	QPSK	128	02 02 02 00 00 01 01 00 02 02 03 03 00 02 03 02
0	PBCH	1/1	QPSK	144	03 02 00 00 01 03 00 03 02 02 01 00 03 03 01 01
0	PBCH	1/1	QPSK	160	03 01 01 00 01 00 02 00 01 02 01 03 00 00 02 03

The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.

- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Bit Index**
- **Bit Stream**
  The actual bit stream.

SCPI command:
CALCulate<screenid>:FEED 'STAT:BSTR'

7 Using the Marker

The firmware application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

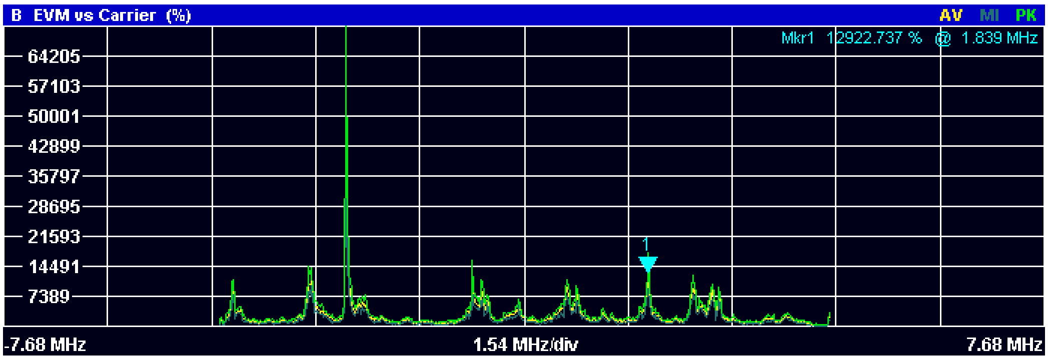


Fig. 7-1: Example: Marker

The MKR key opens the corresponding submenu. You can activate the marker with the "Marker 1" softkey. After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states:

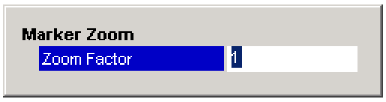
If the "Marker 1" softkey is black, the marker is off.

After pressing the "Marker 1" softkey it turns orange to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

After closing the dialog box, the "Marker 1" softkey turns blue. The marker stays active.

Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.



Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker -> Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

CALCulate<n>:MARKer<m>[:STATe] on page 78

CALCulate<n>:MARKer<m>:AOFF on page 78

CALCulate<n>:MARKer<m>:TRACe on page 79

CALCulate<n>:MARKer<m>:X on page 79

CALCulate<n>:MARKer<m>:Y on page 79

8 The Sweep Menu

The sweep menu contains functions that control the way the R&S FSVR performs a measurement.

Single Sweep and Continuous Sweep

In continuous sweep mode, the R&S FSVR continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSVR captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSVR interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

SCPI command:

`INITiate:CONTinuous` on page 99

Auto Level

The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

If you start the process while a measurement is running, the R&S FSVR aborts the measurement and starts the automatic leveling process. Measurements in continiuous sweep mode are resumed after the auto level is complete.

SCPI command:

`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 111

Refresh

Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSVR updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

SCPI command:

`INITiate:REFResh` on page 99

9 File Management

9.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<?xml version="1.0" encoding="utf-8"?>
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0" RessourceBlocks="50"
CP="auto" RefSigSubcarrierOffset="Auto" PSYNCBoostingdB="0" SSYNCBoostingdB="0"
ReferenceSignalBoostingdB="0" PBCHSymbolOffset="7" PBCHLength="4" PCFICHIsPresent="false"
PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="0" PDCCHIsPresent="false"
PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="2" MIMOConfiguration="1 Tx Antenna"
MIMOAntennaSelection="Antenna 1" PhysLayCellIDGrp="Auto" PhysLayID="Auto"
RefSignal3GPPVersion="2" N_c_fastforward="0">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK" Precoding="None" Layers="1"
Codebook="0" CDD="0"/>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1" EVMCalculationMethod="1"
EnableScrambling="1" AutoDemodulation="1"/>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

Note that at least one PRB must exist.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

Loading an I/Q File

The R&S FSVR is able to process I/Q data that has been captured with a R&S FSVR directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

9.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSVR. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSVR.

10 Further Information

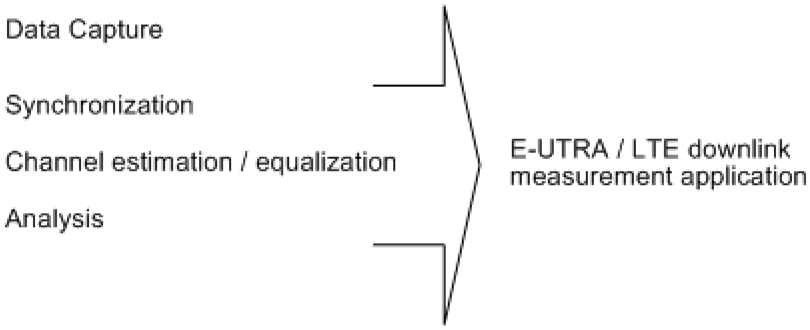
10.1 Measurements in Detail

This section provides a detailed explanation of the measurements provided by R&S FSVR-K100/-K104 and provides help for using R&S FSVR-K100/-K104 to measure the characteristics of specific types of DUT.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{sc}	number of subcarriers
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
r(i)	received sample in the time domain
$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time
T_g	guard time
T_s	symbol time

10.1.1 Introduction

The following description provides a brief overview of the digital signal processing used in the R&S FSVR's EUTRA/LTE measurement application. Between the received IF signal as the point of origin to the actual analysis results such as EVM, the digital signal processing can be divided into four major groups:



The remainder of this description is structured accordingly.

10.1.2 Signal Processing

Data Capturing

The block diagram in figure 10-1 shows the R&S FSVR hardware from the IF section to the processor running the E-UTRA/LTE measurement application. The selectable IF filter bandwidth ranges from 300 kHz to 50 MHz. The A/D converter samples the IF signal at a rate of 81.6 MHz. The digital signal is converted down to the complex baseband, is lowpass-filtered, and is resampled to the nearest multiple of the target sampling rate. The decimation filters suppress the aliasing frequencies arising from the subsequent down-sampling to the target rate. Up to 16 M samples of the now available I/Q data can be stored in the capture buffer.

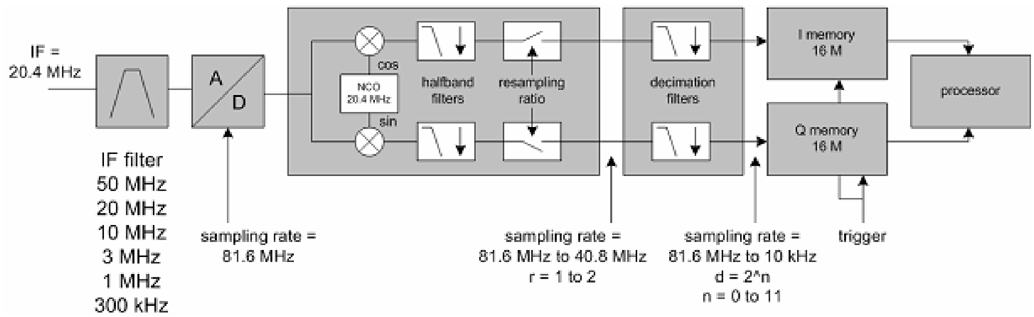


Fig. 10-1: Data Capturing Mechanism of the R&S FSVR

10.1.3 E-UTRA / LTE Downlink Measurement Application

The block diagram in figure 10-2 shows the E-UTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

10.1.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbol in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{\imath}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation, the block "window" produces three signals taken at the timing offsets Δc, Δt_l and Δt_h. For the reference path, only the signal taken at the time offset Δc is used.

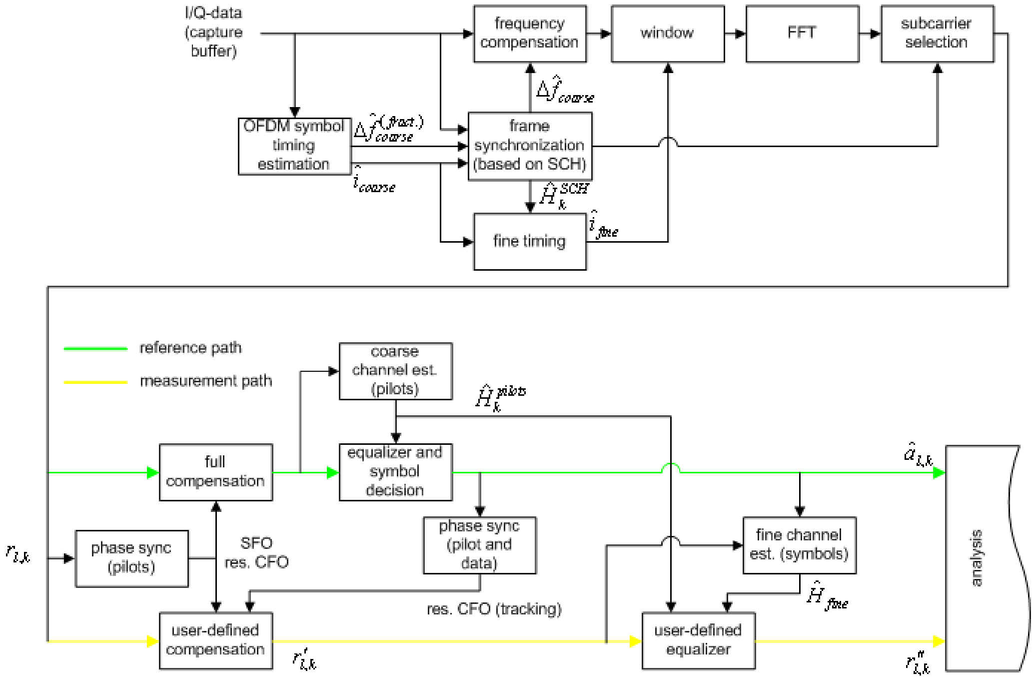


Fig. 10-2: EUTRA/LTE Downlink Measurement Application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l

According to Speth et. al., 1999 [7] and Speth et. al., 2001 [8], the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k} \quad (10 - 1)$$

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T=T_s-T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

10.1.3.2 Channel Estimation / Equalization

As shown in figure 10-2, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation $\hat{H}_{l,k}$ as defined in [3] is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

10.1.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows you to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results "EVM PDSCH QPSK/16-QAM/64-QAM" are calculated according to the specification in [3].

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k} \sqrt{E\left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}}$$

(10 - 2)

on subcarrier k at OFDM symbol l, where $b_{l,k}$, is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, equation 10-2 can be rewritten as

$$EVM_{n,l} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}}$$

(10 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{SC}} \sum_{l} \sum_{k_d} EVM^2_{l,k_d}}$$

(10 - 4)

The number of subcarriers taken into account is denoted by N_{sc}.

I/Q Imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(10 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(10 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(10 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$

Other measurement variables

Without going into detail, the E-UTRA/LTE downlink measurement application additionally provides the following results:

- Total power
- Constellation diagram

- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

10.2 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

10.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSVR stores the information in a number of files that are located in the R&S FSVR directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde&Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

11 Remote Control

This section describes all the remote control commands available for the R&S FSVR EUTRA/LTE Measurement Application.

Note that this manual contains only commands that are exclusive to the firmware application. For information on remote control commands that are also available in the base unit, refer to the Operating Manual of the R&S FSVR. Also refer to the Quick Start Guide and the Operating Manual of the base unit for detailed information on working with remote control commands.

11.1 Numeric Suffix Definition

Some of the remote control commands that are described on the following pages have numeric suffixes in their syntax. Numeric suffixes are used if a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command.

Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

The description of the commands below does not contain the ranges and description of the suffixes. Instead, the syntax contains a variable only. When using the command, replace the variable with the numeric suffixes defined in this section.

<n> = <1...2>

This suffix selects the measurement screen. Possible values are <1...2> with

1 selecting screen A and

2 selecting screen B.

<m> = <1>

This suffix selects the marker. At this point, the application only supports one marker, therefore the possible range is <1>.

<analyzer> = <1...4>

This suffix selects the analyzer the setting applies to. Possible are values are <1...4>.

<subframe> = <0...39>

This suffix selects the subframe that you want to analyze (see chapter 5.2.2.3, "Configuring PDSCH Subframes", on page 39). Depending on your configuration, possible values are <0...9>.

<allocation> = <0...99>

This suffix selects the allocation that you want to analyze (see chapter 5.2.2.3, "Configuring PDSCH Subframes", on page 39). Depending on your configuration, possible values are <0...99>.

11.2 CALCulate Subsystem

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType> String containing the short form of the result display.

'EVM:EVCA' (EVM vs carrier result display)

'EVM:EVRP' (EVM vs RB)

'EVM:EVSY' (EVM vs symbol result display)

'EVM:FEVS' (frequency error vs symbol result display)

'EVM:EVSU' (EVM vs subframe result display)

'PVT:CBUF' (capture buffer result display)

'SPEC:SEM' (spectrum emission mask)

'SPEC:ACP' (ACLR)

'SPEC:PSPE' (power spectrum result display)

'SPEC:PVRP' (power vs RB PDSCH result display

'SPEC:PVRR' (power vs RB RS result display)

'SPEC:FLAT' (spectrum flatness result display)

'SPEC:GDEL' (group delay result display)

'SPEC:FDIF' (flatness difference result display)

SPEC:IE (inband emission result display: uplink only)

'CONS:CONS' (constellation diagram)

CONS:DFTC (DFT precoded constellation diagram: uplink only)

'STAT:BSTR' (bitstream)

'STAT:ASUM' (allocation summary)

'STAT:CCDF' (CCDF)

Example: `CALC2:FEED 'PVT:CBUF'`
Select Capture Buffer to be displayed on screen B.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m> 1

Return values:
<ACPResults> The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

Usage: Query only

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`

Switches on marker 3.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> **1 to 6**

Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`

Assigns marker 3 to trace 2.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`

Positions marker 2 to frequency 1.7 MHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Return values:

<Result> Position of the marker.

Example:
```
INIT:CONT OFF
```
Switches to single measurement mode.
```
CALC:MARK2 ON
```
Switches marker 2.
```
INIT;*WAI
```
Starts a measurement and waits for the end.
```
CALC:MARK2:Y?
```
Outputs the measured value of marker 2.

Usage: Query only

11.3 CONFigure Subsystem

CONFigure[:LTE]:DL:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW10_00

Example: `CONF:DL:BW BW1_40`

Sets a signal bandwidth of 1.4 MHz in downlink.

CONFigure[:LTE]:DL:CONS:LOCation <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location>

AMD
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example: `CONF:DL:CONS:LOC AMD`

Use data from after the MIMO decoder.

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes> Range: 0 to 39

*RST: 1

Example: `CONF:DL:CSUB 5`

Sets the number of configurable subframes to 5.

CONFigure[:LTE]:DL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: `CONF:DL:CYCP EXT`
Sets cyclic prefix type to extended.

CONFigure[:LTE]:DL:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<Antenna>

ANT1 | ANT2 | ANT3 | ANT4
Select a single antenna to be analyzed

AUT1

*RST: ANT1

Example: `CONF:DL:MIMO:ASEL ANT3`
Selects antenna 3 to be analyzed.

CONFigure[:LTE]:DL:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas>

TX1
Use one Tx-antenna

TX2
Use two Tx-antennas

TX4
Use four Tx-antennas

*RST: TX1

Example: `CONF:DL:MIMO:CONF TX2`
TX configuration with two antennas is selected.

CONFigure[:LTE]:DL:MIMO:CROSstalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:DL:MIMO:CROS ON`
Turns crosstalk compensation on.

CONFigure[:LTE]:DL:NORB <ResourceBlocks>

This command selects the number of resource blocks for downlink signals.

Parameters:
<ResourceBlocks> <numeric value>
*RST: 50

Example: `CONF:DL:NORB 25`
Sets the number of resource blocks to 25.

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PBCH:POW -1.1`
Sets the relative power to -1.1 dB.

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:PBCH:STAT ON`
Activates the PBCH.

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PCF:POW 0`
Sets the relative power to 0 dB.

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:DL:PCF:STAT ON`

Activates the PCFICH.

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:

<Format> -1 | 0 | 1 | 2 | 3

*RST: -1

Example: `CONF:DL:PDCCH:FORM 0`

Sets the PDDCH format to 0.

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH> <numeric value>

*RST: 0

Example: `CONF:DL:PDCCH:NOPD 3`

Sets the number of DPCCHs to 3.

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`

Sets the relative power to -1.2 dB.

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration>

NORM
Normal

EXT
Extended

*RST: NORM

Example: `CONF:DL:PHIC:DUR NORM`
Selects normal PHICH duration.

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:DL:PHIC:MITM ON`
Activates PHICH TDD m_i=1 (E-TM)

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng> NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM

Select NG_CUSTOM to customize N_g. You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICh:NOGRoups`.

*RST: NG1_6

Example: `CONF:DL:PHIC:NGP NG1_6`
Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.
`CONF:DL:PHIC:NGP NG_CUSTOM`
Define a customized value for N_g.
`CONF:DL:PHIC:NOGR 5`
Directly sets the number of PHICH groups in the subframe to 5.

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>

*RST: 0

Example: `CONF:DL:PHIC:NOGR 5`
Sets number of PHICH groups to 5.

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>

*RST: -3.01 dB
Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`
Sets the relative power to -1.3 dB.

CONFigure[:LTE]:DL:PSOFfset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<Offset> **AUTO**
Automatically determines the symbol offset.

<numeric value>
Manual selection of the symbol offset.

Range: 0 to 4
*RST: AUTO

Example: `CONF:DL:PSOF 2`
Sets an offset of 2 symbols.

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:REFS:POW -1.2`
Sets a relative power of -1.2 dB.

CONFigure[:LTE]:DL:PLC:PLID <CellIdentity>

Parameters:

<CellIdentity> MNEM | AUTO

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>

*RST: 1

Example: `CONF:DL:SUBF2:ALC 5`

Defines 5 allocations for subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>

*RST: 0 dB

Default unit: DB

Example: `CONF:DL:SUBF2:ALL5:POW -1.3`

Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount <ResourceBlocks>

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:

<ResourceBlocks> <numeric value>

*RST: 6

Example: `CONF:DL:SUBF2:ALL5:RBC 25`

Defines 25 resource block for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset <Offset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<Offset> <numeric value>

*RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`

Defines a resource block offset of 3 for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]: MODulation <Modulation>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum> 1..n
Selects the codeword.

Parameters:

<Modulation> **QPSK**
QPSK modulation
QAM16
16QAM modulation
QAM64
64QAM modulation
*RST: QPSK

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE
*RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
All antennas are used to transmit the P-SYNC and S-SYNC.

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:PPOW 0.5`
Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:SPOW 0.5`
Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>

Numeric value that defines the subframe configuration.
Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8
*RST: 0

Example: `CONF:DL:CYCP NORM`
Selects normal cyclic prefix.
`CONF:DL:TDD:SPSC 7`
Selects subframe configuration 7, available only with a normal cyclic prefix.

CONFigure[:LTE]:DL:TDD:UDConf <Configuration>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<Configuration> Range: 0 to 6
*RST: 0

Example: `CONF:DL:TDD:UDC 2`
Selects allocation configuration number 2.

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`
Activates time division duplex.

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

CONFigure:POWer:EXPected:IQ<analyzer> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLevel> <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

Example: `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

CONFigure:POWer:EXPected:RF<analyzer> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel> *RST: -30 dBm
Default unit: DBM

Example: `CONF:POW:EXP:RF3 -20`
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

11.4 DISPlay Subsystem

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example: `DISP:WIND2:SEL`
Selects screen B.

Usage: Event

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation> <numeric value>

*RST: 0
Default unit: dB

Example: `DISP:TRAC:Y:RLEV:OFFS 10`
Sets an external attenuation of 10 dB.

11.5 FETCh Subsystem

FETCh:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType> The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: `FETC:CYCP?`
Returns the current cyclic prefix length type.

Usage: Query only

FETCh:PLCI:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

Example: `FETC:PLCI:CIDG?`
Returns the current cell identity group.

Usage: Query only

FETCh:PLCI:PLID?

This command queries the cell identity that has been detected.

Return values:

<CellIdentity> The command returns -1 if no valid result has been detected yet.

Range: 0 to 2

Example: `FETC:PLCI:PLID?`
Returns the current cell identity.

Usage: Query only

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:
<CrestFactor> <numeric value>

Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

FETCh:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:
<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSQP?`
Returns the PDSCH QSPK EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:
<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSSF?`
Returns the PDSCH 64QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:
<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSST?`
Returns the PDSCH 16QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PCH:MAX?`
Returns the maximum value.
`FETC:SUMM:EVM:PCH:MIN?`
Returns the minimum value.
`FETC:SUMM:EVM:PCH?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG:MAX?`
Returns the maximum value.
`FETC:SUMM:EVM:PSIG:MIN?`
Returns the minimum value.
`FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:MAX?`
Returns the maximum value.
`FETC:SUMM:EVM:MIN?`
Returns the minimum value.
`FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`

Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP:MAXimum
FETCh:SUMMary:OSTP:MINimum
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:OSTP?`

Returns the current average OSTP value.

Usage: Query only

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`

Returns the total power in dBm

Usage: Query only

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`
Returns the current mean quadrature error in degrees.

Usage: Query only

FETCh:SUMMary:RSTP:MAXimum
FETCh:SUMMary:RSTP:MINimum
FETCh:SUMMary:RSTP[:AVERage]?

This command queries the reference signal transmit power (RSTP).

Return values:

<RSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:RSTP?`
Returns the current average RSTP value.

Usage: Query only

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`
Returns the current mean sampling error in ppm.

Usage: Query only

FETCh:SUMMary:TAE<antenna>?

This command queries the time alignment error.

Suffix:

<antenna> 2..4
Number of the antenna you want to compare to antenna 1.

Return values:

<TimeAlignError>
Time alignment error of antenna 1 and another antenna.

Usage: Query only

FETCh:SUMMary:TFRame?

This command queries the trigger to frame result for downlink signals and the trigger to subframe result for uplink signals.

Return values:

<TrigToFrame> <numeric value>
Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the trigger to frame value.

Usage: Query only

11.6 FORMat Subsystem

FORMat[:DATA] [<Format>]

Specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCii | REAL
*RST: ASCii

Return values:

<BitLen>

Example: `FORM REAL`
The software will send binary data in Real32 data format.

11.7 INITiate Subsystem

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: `INIT`
Initiates a new measurement.

Usage: Event

INITiate:CONTinuous <State>

This command controls the sweep mode.

Parameters:
<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: OFF

Example: `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example: `INIT:REFR`
The application updates the IQ results

Usage: Event

11.8 INPut Subsystem

INPut<n>:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation for an analyzer in the test setup.

Parameters:

<Attenuation> <numeric value>

*RST: 5 dB
Default unit: dB

Example: `INP:ATT 10`
Defines an RF attenuation of 10 dB.

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:

<ScaleLevel> Numeric value

*RST: 1 V
Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate> *RST: 10 MHz
Default unit: Hz

Example: `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

INPut:EATT:AUTO <State>

Switches the automatic behaviour of the electronic attenuator on or off. If activated, electronic attenuation is used to reduce the operation of the mechanical attenuation whenever possible.

This command is only available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP1:EATT:AUTO OFF`

Mode: all

INPut:SELect <Source>

This command selects the data source.

Parameters:

<Source>

RF
Selects the RF input as the data source.

AIQ
Selects the analog baseband input as the data source. This source is available only with option R&S FSVR-B71.

DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSVR-B17.

11.9 INSTrument Subsystem

INSTrument[:SELect] <Mode> | <ChannelName>

This command selects the measurement mode by means of text parameters.

Parameters:

<Mode>

SANalyzer
Spectrum mode

ADEMod
Analog demodulation mode
(Analog Demodulation option, R&S FSV-K7)

SFM
FM Stereo (R&S FSV–K7S option)

BTOoth
Bluetooth mode (R&S FSV-K8 option)

GSM | MGSM
GSM mode (R&S FSV-K10 option)
Query returns `MGSM`.

NOISe
Noise Figure Measurements option, R&S FSV-K30

PNOise
Phase Noise mode (R&S FSV-K40 option)

DDEM
VSA mode (R&S FSV-K70 option)

BWCD
3G FDD BTS Mode (R&S FSV-K72 option)

MWCD
3G FDD UE Mode (R&S FSV-K73 option)

BTDS
TD-SCDMA BTS mode (R&S FSV-K76 option)

MTDS
TD-SCDMA UE mode (R&S FSV-K77 option)

BC2K
CDMA2000 BS Analysis mode (R&S FSV-K82 option)

BDO
1xEV-DO BS Analysis option, R&S FSV-K84

WLAN
WLAN TX mode (R&S FSV-K91/91n option)

WiMAX
WiMax mode (WiMAX 802.16 OFDM Measurements option and WiMAX IEEE 802.16 OFDM, OFDMA Measurements option, R&S FSV-K93)

LTE
LTE measurement application (uplink and downlink)

*RST: SANalyzer

Example:

`INST SAN`
Switches the instrument to "Spectrum" mode.

Usage: SCPI confirmed

Mode: all

INSTrument:NSELect <Mode>

This command selects the operating mode by means of numbers.

Parameters:

<Mode>
Selects the operating with numbers.

1
Spectrum mode

2
VSA mode (R&S FSV-K70 option)

3
Analog demodulation mode

5
GSM mode (R&S FSV-K10 option)

6
Selects WiMax mode (WiMAX IEEE 802.16 OFDM, OFDMA Measurements option, R&S FSV-K93)

7
FM Stereo (R&S FSV–K7S option)

8
3G FDD BTS Mode (R&S FSV-K72 option)

9
3G FDD UE Mode (R&S FSV-K73 option)

10
CDMA2000 BS Analysis mode (R&S FSV-K82 option)

12
Bluetooth mode (R&S FSV-K8 option)

14
1xEV-DO BS Analysis mode (R&S FSV-K84 option)

16
Selects WLAN TX mode (R&S FSV-K91/91n option)

17
TD-SCDMA BTS mode (R&S FSV-K76 option)

18
TD-SCDMA UE mode (R&S FSV-K77 option)

19
Noise Figure mode (R&S FSV-K30 option)

20
Phase Noise mode ((R&S FSV-K40 option)

23
Selects WiMax mode (WiMAX 802.16 OFDM Measurements option, R&S FSV-K93

100
LTE measurement application (uplink and downlink)

*RST: 1

Example:
`INST:NSEL 1`
Switches the instrument to "Spectrum" mode.

Usage:
SCPI confirmed

Mode: all

11.10 MMEMory Subsystem

MMEMory:LOAD:DEModsettings <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:

<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>

'E-TM1_1__10MHz'
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__10MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__10MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__10MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__10MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__10MHz'
EUTRA Test Model 3.3 (E-TM3.3)

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

11.11 SENSe Subsystem

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example:

`FRAM:COUN:STAT ON`

Activates manual input of frames to be analyzed.

`FRAM:COUN 20`

Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>

ON

Selects the number of frames to analyze according to the LTE standard.

OFF

Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`
Turns automatic selection of the analyzed frames on.

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:
<State>
ON
You can set the number of frames to analyze.
OFF
The R&S FSVR analyzes a single sweep.
*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `DL:DEM:AUTO ON`
Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `DL:DEM:BEST ON`
Turns boosting estimation on.

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `DL:DEM:CBSC ON`
Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type>

TGPP
3GPP EVM definition

PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

*RST: TGPP

Example: `DL:DEM:CEST TGPP`
Use 3GPP EVM definition for channel estimation.

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation>

TGPP
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: `DL:DEM:EVMC TGPP`
Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DL:DEM:MCF ON`
Turns suppression on of neighboring carriers on.

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:
<Reference>

AUTO
Automatic identification of reference data.

ALL0
Reference data is 0, according to the test model definition.

Example:
`DL:DEM:PRD ALL0`
Sets the reference data of the PDSCH to 0.

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:
<Format>

OFF
Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH
Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET
Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example:
`DL:FORM:PSCD OFF`
Applies the user configuration and does not check the received signal

---

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:
<Type>

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example:
`DL:TRAC:PHAS PILPAY`
Use pilots and payload for phase tracking.

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DL:TRAC:TIME ON`
Activates timing tracking.

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: `FREQ:CENT 2GHZ`
Set the center frequency to 2 GHz.

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example:

`POW:ACH:AACH UTRA384`
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>

OFF
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection before each measurement.

ONCE
Performs an automatic reference level once.

*RST: ON

Example:

`POW:AUTO2 ON`
Activate auto level for analyzer number 2.

[SENSe]:POWer:AUTO<analyzer>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time>

<numeric value>

*RST: 100 ms
Default unit: s

Example:

`POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `POW:NCOR ON`
Activates noise correction.

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category> A | B

*RST: A

Example: `POW:SEM:CAT B`
Selects SEM category B.

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.

Default unit: s

Example: `SWE:TIME 40`
Defines a capture time of 40 seconds.

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State>
The string contains the following information.
- <OFDMSymbolTiming> is the coarse symbol timing
- <P-SYNCSynchronization> is the P-SYNC synchronization state
- <S-SYNCSynchronization> is the S-SYNC synchronization state

A zero represents a failure and a one represents a successful synchronization.

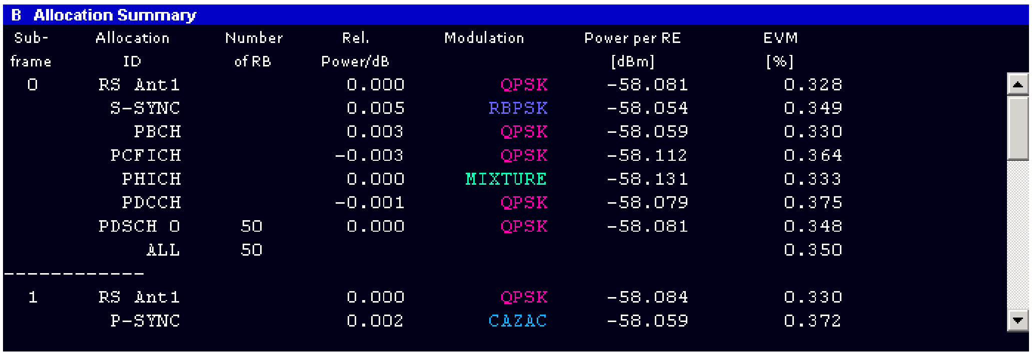
Example:
`SYNC:STAT?`
Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage:
Query only

11.12 TRACe Subsystem

Example for querying the results of the allocation summary result display

This section shows an example of what the R&S FSVR will return when the Allocation Summary result display is queried with the TRACe[:DATA] command.



B Allocation Summary

Sub-frame	Allocation ID	Number of RB	Rel. Power/dB	Modulation	Power per RE [dBm]	EVM [%]
0	RS Ant1		0.000	QPSK	-58.081	0.328
	S-SYNC		0.005	RBPSK	-58.054	0.349
	PBCH		0.003	QPSK	-58.059	0.330
	PCFICH		-0.003	QPSK	-58.112	0.364
	PHICH		0.000	MIXTURE	-58.131	0.333
	PDCCH		-0.001	QPSK	-58.079	0.375
	PDSCH 0	50	0.000	QPSK	-58.081	0.348
	ALL	50				0.350

1	RS Ant1		0.000	QPSK	-58.084	0.330
	P-SYNC		0.002	CAZAC	-58.059	0.372

Fig. 11-1: Display of the allocation summary

The TRACe[:DATA] command would return this:

```
<subframe>, <allocation ID>, <number of RB>, <relative power>,
<modulation>, <power in dBm>, <EVM in dB or %>, ...
```

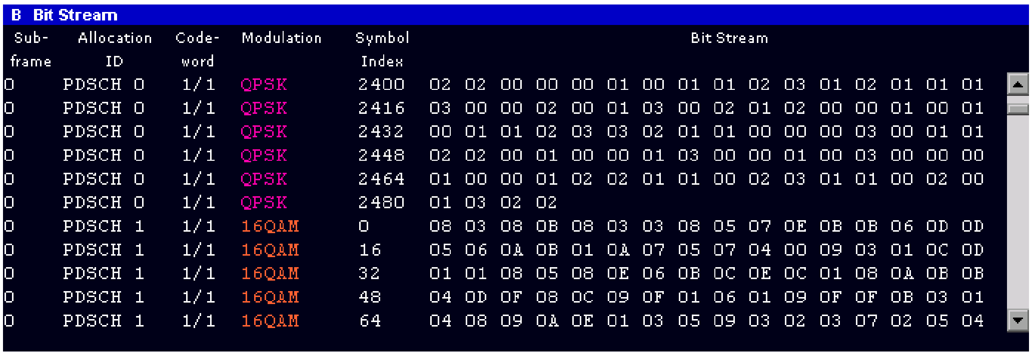
Each line in this example corresponds to one set of values.

```
0,-5,,,0,-17.0926996097583,8.44728660354122E-06,
0,-3,,,0,-17.742108013101,8.49192574037261E-06,
0,-4,,,0,-17.7421077124897,8.50963104426228E-06,
0,-12,,,2,-17.092699868618,7.81896929424875E-06,
0,0,3,0,4,-17.1774446884892,8.54281765327869E-06,
0,1,1,3,3,-17.1688944558343,9.53971195372105E-06,...

<continues like this until the end of data is reached>
```

Example for querying the results of the bitstream result display

This section shows an example of what the R&S FSVR will return when the Bitstream result display is queried with the TRACe[:DATA] command.



B Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PDSCH 0	1/1	QPSK	2400	02 02 00 00 00 01 00 01 01 02 03 01 02 01 01 01
0	PDSCH 0	1/1	QPSK	2416	03 00 00 02 00 01 03 00 02 01 02 00 00 01 00 01
0	PDSCH 0	1/1	QPSK	2432	00 01 01 02 03 03 02 01 01 00 00 00 03 00 01 01
0	PDSCH 0	1/1	QPSK	2448	02 02 00 01 00 00 01 03 00 00 01 00 03 00 00 00
0	PDSCH 0	1/1	QPSK	2464	01 00 00 01 02 02 01 01 00 02 03 01 01 00 02 00
0	PDSCH 0	1/1	QPSK	2480	01 03 02 02
0	PDSCH 1	1/1	16QAM	0	08 03 08 0B 08 03 03 08 05 07 0E 0B 0B 06 0D 0D
0	PDSCH 1	1/1	16QAM	16	05 06 0A 0B 01 0A 07 05 07 04 00 09 03 01 0C 0D
0	PDSCH 1	1/1	16QAM	32	01 01 08 05 08 0E 06 0B 0C 0E 0C 01 08 0A 0B 0B
0	PDSCH 1	1/1	16QAM	48	04 0D 0F 08 0C 09 0F 01 06 01 09 0F 0F 0B 03 01
0	PDSCH 1	1/1	16QAM	64	04 08 09 0A 0E 01 03 05 09 03 02 03 07 02 05 04

Fig. 11-2: Display of the bitstream

The TRACe[:DATA] command would return this:

```
<subframe>, <allocation ID>, <codeword>, <modulation>, <number of
symbols or bits>, <hexadecimal or binary numbers>, ...
```

Each line in this example corresponds to one set of values.

```
0,-12,0,2,239,01,00,02,01,01,00,00,00,00,00,01,01,
01,00,00,00,03,00,01,01,01,02,01,00,03,03,00,01,01,02,02,...

<continues like this until the next data block starts or the end of data is reached>

...,0,0,0,4,413,1D,2B,27,03,24,07,35,05,1F,22,20,15,
17,0C,21,34,10,2C,09,32,19,03,11,36,19,2A,05,0A,0F,0F,04,...

<continues like this till next datablock starts or end of data reached>
```


TRACe[:DATA]? <TraceNumber> | LIST

This command returns the trace data for the current measurement or result display. You can change the format of the returned data with the FORMat[:DATA] command.

ASCII format (FORMat ASCII): In ASCII format, a list of values separated by commas is returned (Comma Separated Values = CSV). Empty fields will return NAN.

Binary format (FORMat REAL,32): If the transmission takes place using the binary format (REAL,32), the data are transferred in block format (Definite Length Block Data according to IEEE 488.2). They are arranged in succeeding lists of I and Q data of 32 Bit IEEE 754 floating point numbers.

The returned values are scaled in the current measurement unit. For some measurements the unit may change depending on the unit set with UNIT:EVM.

The format of the data that is returned is specific to each result display and is specified below.

- **Capture Buffer**

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer. The unit is dBm.

- **EVM vs Carrier**
  For the EVM vs Carrier result display, the command returns one value for each subcarrier. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean EVM (averaged over all subframes)
  TRACE2: Minimum EVM or nothing if a single subframe is selected
  TRACE3: Maximum EVM or nothing if a single subframe is selected
- **EVM vs Symbol**
  For the EVM vs Symbol result display, the command returns a value for each OFDM symbol. If you select a single subframe (`[SENSe][:LTE]:SUBFrame:SELect`), the command returns only the symbols of that subframe. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns data only for parameter TRACE1.
- **Frequency Error vs Symbol**
  For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol.
  <frequency error in Hz>, ...
  The command returns data only for parameter TRACE1.
- **EVM vs Subframe**
  For the EVM vs Subframe result display, the command returns a value for each subframe. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns data only for parameter TRACE1.
- **Spectrum Emission Mask**
  For the Spectrum Emission Mask result display, the command returns one value for each trace point for parameter TRACE1.
  <power in dBm>
  For parameter LIST, it returns the contents of the SEM table.
  <index in result table>, <start frequency band in Hz>, <stop frequency band in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <failure flag>, ...
  The <failure flag> element returns 1 for FAIL and 0 for PASS.
- **Adjacent Channel Leakage Ratio**
  For the ACLR result display, the command returns one value for each trace point for parameter TRACE1.
  <power in dBm>, ...
  For parameter LIST, it returns the contents of the ACLR table.
- **Power Spectrum**
  For the Power Spectrum result display, the command returns the signal power in dBm/Hz as list over the considered frequency span for parameter TRACE1
  <power in dB>
- **Power vs RB RS**

For the Power vs RB RS result display, the command returns one value for each resource block (RB) of the reference signal.
<power in dBm>, ...
The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
TRACE1: Mean power of the reference signal per RB (averaged over all subframes)
TRACE2: Minimum power of the reference signal per RB or nothing if a single subframe is selected
TRACE3: Maximum power of the reference signal per RB or nothing if a single subframe is selected

- **Power vs RB PDSCH**
  For the Power vs RB PDSCH result display, the command returns one value for each resource block (RB) of the PDSCH.
  <power in dBm>, ...
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean power of the reference signal per RB (averaged over all subframes)
  TRACE2: Minimum power of the reference signal per RB or nothing if a single subframe is selected
  TRACE3: Maximum power of the reference signal per RB or nothing if a single subframe is selected
- **Channel Flatness**
  For the Channel Flatness result display, the command returns one value for each trace point.
  <spectrum flatness in dB>, ...
  The number of trace points depends on the LTE bandwidth.
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: mean power of the channel flatness (averaged over all subframes)
  TRACE2: minimum power of the channel flatness or nothing if a single subframe is selected
  TRACE3: maximum power of the channel flatness or nothing if a single subframe is selected
- **Channel Group Delay**
  For the Channel Group Delay result display, the command returns one value for each trace point.
  <channel group delay in ns>
  The number of trace points depends on the LTE bandwidth.
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean time of the channel group delay (averaged over all subframes)
  TRACE2: Minimum time of the channel group delay or nothing if a single subframe is selected
  TRACE3: Maximum time of the channel group delay or nothing if a single subframe is selected
- **Channel Flatness Difference**
  For the Channel Flatness Difference result display, the command returns one value for each trace point.
  <channel flatness difference in dB>, ...

The number of trace points depends on the LTE bandwidth.
The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
TRACE1: Mean power of the channel flatness difference (averaged over all subframes)
TRACE2: Minimum power of the channel flatness difference or nothing if a single subframe is selected
TRACE3: Maximum power of the channel flatness difference or nothing if a single subframe is selected

- **Constellation Diagram**
  For the Constellation Diagram result display, the command returns an array of interleaved I and Q data until all data is exhausted.
  By default, the command returns all measured data points. You can reduce the amount of data by filtering the results via "Constellation Selection" on page 61.
  Constellation data is returned in the following order.
  - Subframe 0, Symbol 0: first to last carrier of symbol 0
  - Subframe 0, Symbol 1: first to last carrier of symbol 1
  - Subframe 0, (...) to last symbol of subframe 0
  - Subframe 1, Symbol 0: first to last carrier of symbol 0
  - Subframe 1, Symbol 1: first to last carrier of symbol 1
  - Subframe 1, (...) to last symbol of subframe 1
  - (...) to last subframe

  TRACE1: all constellation data covered by the selection
  TRACE2: reference symbols covered by the selection
  TRACE3: sounding reference signal covered by the selection
- **CCDF**
  For the Complementary Cumulative Distribution Function result display, the command returns the probability over the power level.
  The first value returned represents the number of following values.
  The command returns the following for parameter TRACE1 to TRACE2
  TRACE1: returns the values of the y-axis: <probability value in %>
  TRACE2: returns the corresponding values of the x-axis: <power steps in dB>
- **Allocation Summary**
  For the Allocation Summary result display, the command returns seven values for each line of the allocation summary table.
  <subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <power in dBm>, <EVM in dB or %>, ...
  This command is not available for Real32 data format and will therefore always return ASCII formatted data.
- **Bitstream**
  For the BitStream result display, the command returns returns six values for each line in the bitstream table.
  <subframe>, <allocation ID>, <codeword>, <modulation>, <number of symbols or bits>, <hexadecimal or binary numbers>, ...
  This command is not available for Real32 data format and will therefore always return ASCII formatted data.

Parameters:

<hexadecimal or binary numbers> In Hexmode, a comma-separated stream of two-digit hexadecimal numbers and in binary mode a comma-separated stream of binary numbers.

<number of symbols or bits> In Hexmode, the number of symbols to be transmitted and in binary mode the number of bits to be transmitted.

Parameters for setting and query:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**
If you have more than one trace in the result display, this parameter selects the trace whose data you want.

Return values:

<allocation ID> Allocation ID for downlink signals. The range is {-1...-13}
-1= INVALID
-2= ALL
-3= P-SYNC
-4= S-SYNC
-5= PILOTS_ANT1
-6= PILOTS_ANT2
-7= PILOTS_ANT3
-8= PILOTS_ANT4
-9= PCFICH
-10= PHICH
-11= PDCCH
-12= PBCH
-13= PMCH

<codeword> Codeword of the allocation. The range is from {0...2}.
0= '1/1'
1= '1/2'
2= '2/2'

<EVM> EVM is returned either in dB or in %, depending on the unit you have set.

<modulation> Type of modulation. The range is {0...8}.
0= Unrecognized
1= RBPSK (both constellation points are located on the x-axis)
2= QPSK
3= 16QAM
4= 64QAM
5= 8PSK
6= PSK
7= Modulation mixture
8= BPSK

<number of RB> Number of resource blocks.

<subframe> Number of the subframe.

Usage: Query only

11.13 TRIGger Subsystem

TRIGger[:SEQuence]:HOLDoff<analyzer> <Offset>

This command defines the trigger offset.

Parameters:

<Offset> <numeric value>

*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:LEVel<analyzer>[:EXTernal] <Level>

This command defines the level for an IF power trigger.

Parameters:

<Level> Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example: `TRIG:LEV 2V`

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:

<Source>

EXTernal
Selects external trigger source.

IMMediate
Selects free run trigger source.

POWer
Selects IF power trigger source.

PSEN
Selects power sensor trigger source.

RFPower
Selects RF power trigger source.

*RST: IMMediate

Example: `TRIG:MODE EXT`
Selects an external trigger source.

11.14 UNIT Subsystem

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

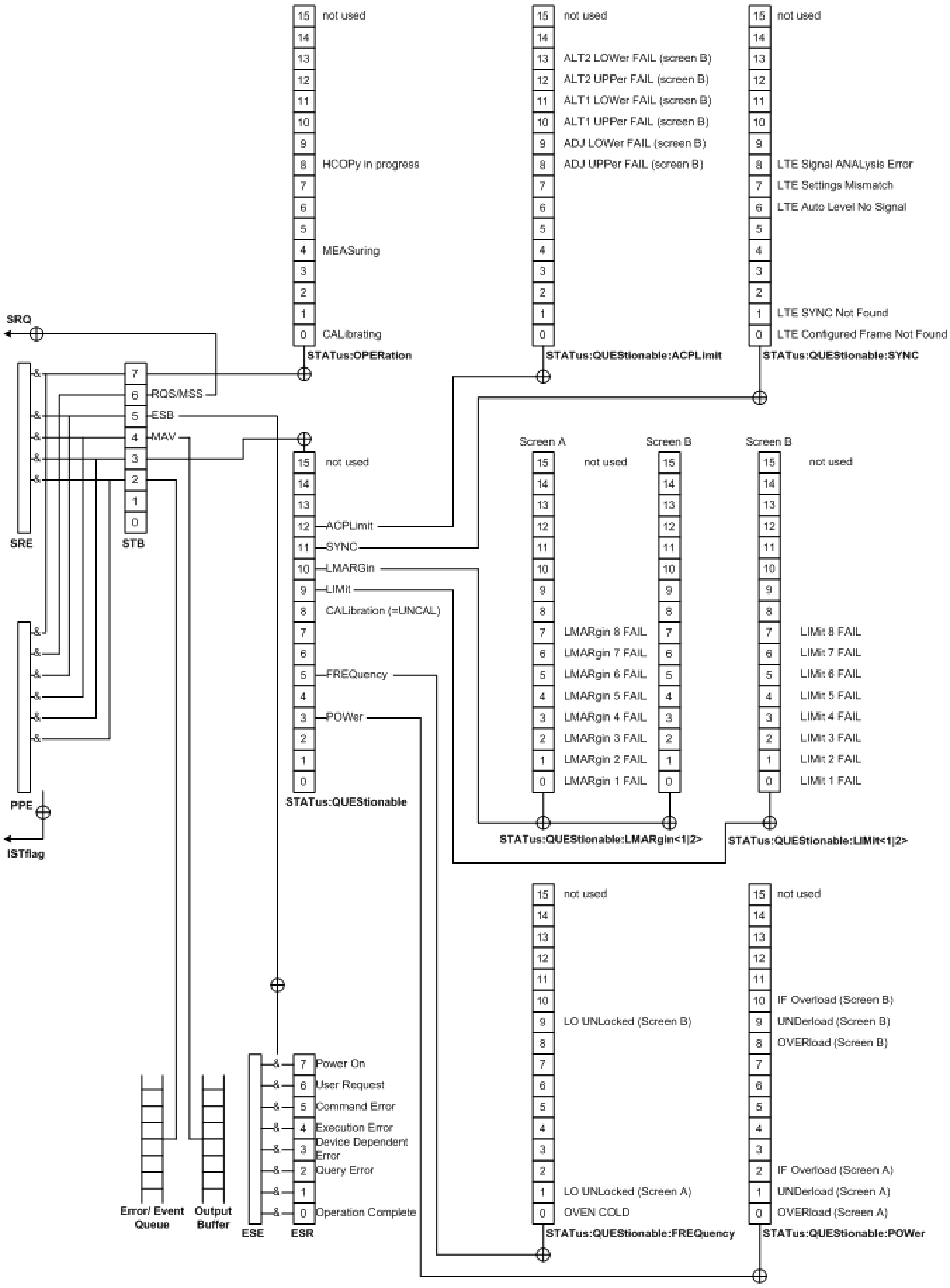
11.15 Status Reporting System (LTE Measurements)

The status reporting system stores information about the current state of the R&S FSVR. This includes, for example, information about errors during operation or information about limit checks. The R&S FSVR stores this information in the status registers and in the error queue. You can query the status register and error queue via IEC bus.

The R&S FSVR structures the information hierarchically, with the Status Byte register (STB) and the Service Request Enable mask register (SRE) being on the highest level. The STB gets its information from the standard Event Status Register (ESR) and the Event Status Enable mask register (ESE). The STB and ESR are both defined by IEEE 488.2. In addition to the ESR, the STB also gets information from the STATus:OPERation and STATus:QUEStionable registers. These are the link to the lower levels of the status register and are defined by SCPI. They contain information about the state of the R&S FSVR.

In addition to the status registers of the base system, the LTE measurement application provides additional or different registers specific to this firmware option. This chapter decribes the registers specific to the LTE measurement applications (uplink and downlink). For a description of the other registers see the operating manual of the R&S FSVR.

Overview of the status register



11.15.1 STATus:QUEStionable:LIMit Register

The STATus:QUEStionable:LIMit register contains information about the results of a limit check when you are working with limit lines.

The LTE measurement application contains one LIMit register only because limit lines are always displayed in screen B.

The number of LIMit registers depends on the number of measurement windows available in any operating mode.

You can read out the register with `STATus:QUEStionable:LIMit[:EVENt]` or `STATus:QUEStionable:LIMit:CONDition`. For more information see the manual of the base unit.

Table 11-1: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8 to 14	Unused
15	This bit is always 0.

11.15.2 STATus:QUEStionable:SYNC Register

The STATus:QUEStionable:SYNC register contains information about the synchronization of the R&S FSVR to the signal.

You can read out the register with `STATus:QUEStionable:SYNC[:EVENt]` or `STATus:QUEStionable:SYNC:CONDition`. For more information see the manual of the base unit.

Table 11-2: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LTE Configured Frame Not Found This bit is set if the application could not find the configured frame. Only possible with uplink measurements.
1	SYNC Not Found This bit is set if the application could not synchronize to the signal. Only possible with downlink measurements.
2 to 5	Unused
6	LTE Auto Level No Signal
7	LTE Settings Mismatch This bit is set if the configuration is not the same as the signal.
8	LTE Signal Analysis Error
9 to 14	Unused
15	This bit is always 0.

List of Commands

Index